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Technical Report: NAVTRAEQUIPCEN 70-C-0258-2

TRAINING EFFECTIVENESS EVALUATION OF NAVAL TRAINING DEVICES: AN EVALUATION OF THE 2F69B ASW WEAPON SYSTEM TRAINER

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Contract N61339-70-C-0258
NAVTRAEQUIPCEN Task No. 8264-2

December 1972

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LIST OF ILLUSTRATIONS (Cont)

FOREWORD

The Naval Training Equipment Center has been involved in a continuing program of training evaluations for the past several years. The primary goal of this effort is to quantify the effects of the use of training systems, and with this information, to improve present and future training utilization and design of training systems. A related goal is to establish the cost effectiveness of such systems.

The present study involved Device 2F69B, a weapon systems trainer for the P-3A and P-3B Aircraft. This device is designed to provide tactics crews with team training in the detection, tracking, and destruction of modern deep-diving submarines. By carefully selecting, varying, and controlling the problem conditions, the instructors should be able to train the tactics teams to properly analyze and respond to situations likely to occur on an actual ASW mission. The intent of this study was to test the performance of these teams to determine how well the training objectives were being met.

The study results indicate that learning takes place in the simulator and that there is positive transfer to the operational environment. There is, however, room for improvement and recommendations are made in several areas for better control of student flow and for modification of the training curriculum.

The importance of clarifying the capabilities of the trainer to the instructors is becoming evident as more training effectiveness evaluations are completed. It is appearing as a common factor, that many training devices are being installed without adequate, formal instruction for their proper utilization. In cases where formal instruction is initially provided, it may be lost through instructor turnover. Thorough indoctrination in the proper use of a training device should be made periodically, in order to utilize the trainer's maximum capabilities. A training device can be only as good as its management by support and training personnel.

Joseph A. Puig

JOSEPH A. PUIG
Project Psychologist

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SECTION I

INTRODUCTION

PURPOSE OF THE STUDY

This report describes the results of experiments performed to evaluate the training effectiveness of the Navy 2F69B Weapon System Trainer. This evaluation effort was an extremely ambitious undertaking for two reasons. First, the trainer is designed to provide training for the entire spectrum of flight and ASW tactics that can be employed by the P3A (and B) ASW aircraft. Second, a principal goal of the study effort was to demonstrate that the device provides effective training for both crews and individual crew members.

GENERAL DESCRIPTION OF THE 2F69B TRAINER

The weapon system trainer for the P3A and B aircraft is housed in two semitrailers. Each trailer is 40 feet long, 10 feet wide, and 12-1/2 feet high. One trailer contains the Operational Flight Trainer (OFT), and the other contains the Weapon System Trainer (WST). The WST is also referred to as the Antisubmarine Warfare (ASW) Tactics Trainer. The OFT and WST segments of the trainer can be operated concurrently to simulate the entire ASW mission of the P3 aircraft or independently to exercise the separate skills required for aircraft operation or submarine detection, tracking, and destruction.

The OFT portion of the trainer is used to train student pilots, copilots, and flight engineers on both normal and emergency aircraft operating procedures, and crew coordination procedures during ASW operations. The WST simulates the five ASW operator stations of the P3A aircraft. These are:

a. Jezebel operator

b. Tactical coordinator (TACCO)

c. Navigator

d. Julie/ECM operator

e. Radar/MAD operator.

The WST trailer also contains instructor consoles and equipments which are utilized to simulate a wide variety of tactical situations. Computer equipment in the WST records the effects of operator performance at each of the crew stations. Indicators located at each crew position are "slaved" to instructor monitoring indicators to enable the instructors to evaluate ongoing operator performance. If an instructor wishes, he can "freeze" simulated conditions at any time during the conduct of a training problem. With the simulator "frozen," the instructor can discuss and correct erroneous performance, and either reset the problem to a new set of initial conditions, or continue the problem from the point at which it was frozen.

COMPARISON OF OFT-WST SEGMENTS FOR EVALUATION PURPOSES

Early in the study it was thought that the flight deck or OFT portion of the trainer would be worthwhile to evaluate. However, conversations with flight engineers and pilot instructors from the training squadron in which the study was to be performed pinpointed a number of difficulties inherent in completing such an evaluation. These were as follows:

a. The OFT was used to teach operating procedures rather than flight performance.

b. The performance of flight engineers is difficult to assess because it is a complex function of pilot, copilot, and flight engineer interaction. The flight engineer seldom initiates an action in the simulator unless he receives instructions from the pilot or copilot.

c. Flight trainees consist primarily of transition students and students undergoing "refresher" training.

d. There was no means for obtaining an automated record of simulator performance for the flight engineers or pilots.

By comparison, the WST portion of the trainer appeared likely to provide an environment that was more conducive to experimentation. For example,

a. The ASW student group was largely composed of students lacking previous ASW experience.

b. Performance measures descriptive of both crew and individual crew member performance was available for each of the crew stations.

c. Alphanumeric and graphic readouts of deviations from "real world" conditions were available at instructor stations.

d. Hard copy output of student performance was available in the form of event logs at each operator station and also in the form of Julie and Jezebel tapes.

e. WST instructors agreed to participate in the data collection portion of the evaluation effort.

f. In the WST, the experimenter was to be allowed to control the complexity levels to be introduced in succeeding training sessions.

On the basis of the comparison of the operating environments existing in the OFT and WST training areas, it was concluded it would be more feasible to complete a meaningful evaluation of training effectiveness in the WST section of the 2F69B trainer.

The evaluation of the WST was accomplished by means of two separate project experiments. Each experiment is described in detail in the material that follows. The descriptions include a delineation of the subject population, experimental design, study measures, and experimental results. Conclusions and recommendations extracted from each study are collected together into a single discussion.

In addition to the 2F69B evaluation, a small cockpit procedures trainer, utilized as a classroom teaching aid was evaluated from a human engineering viewpoint to determine if it could be improved. The results of that evaluation appear in Appendix A to this report.

SECTION II

EXPERIMENT ONE

INTRODUCTION

Experiment One focused on ASW operator performance as it occurred in the simulator. The intent was to determine whether operator performance in terms of accuracy and efficiency improved as the student progressed through five WST training sessions.

EXPERIMENTAL DESIGN

SUBJECT POPULATION. Data were collected on two classes of students composed of six and seven crews respectively. The experimenters were unable to control the number of students being trained during the experimental sessions; consequently, each crew in both classes did not have an equal number of students assigned to each ASW position. The range and average number of students per position per crew appear in table 1.

TABLE 1. STUDY ONE POPULATION DESCRIPTION

Position	First Class	Second Class	Total Number of Students
TACCO	1.7 1 - 2	2.0 2	24
Navigator	1.8 1 - 2	1.9 1 - 3	24
Jezebel	1.3 1 - 2	0.6 0 - 2	12
Julie/ECM	1.5 1 - 2	0.0 0	9
Radar/MAD	1.0 0 - 2	0.3 0 - 1	8

STUDY METHODS

Although the WST sessions varied with respect to mission phase emphasized and the ASW techniques utilized, the general ASW search, localize, and destroy mission profile was employed throughout the program and several mission functions and activities were performed during two or more WST sessions. A repeated measures design with subjects serving as their own controls was used to neutralize the possible effects of individual student differences.

STUDY MEASURES

Data were collected on several objective measures of crew and individual performance. Crew measures describe the accuracy and efficiency with which each ASW mission phase was completed by those crew members responsible for that phase. Error and time data were collected and converted into accuracy and efficiency measures by subtraction from a constant maximum value (e.g., accuracy = constant - error). As a result, subjects achieved maximum scores when they completed a mission task with zero error and minimum time. The emphasis was on providing meaningful descriptions of performance change.

Individual operator measures generally describe the percentage of possible log entries and sensor record annotations accurately completed by the student. The measures of crew and individual performance are defined in greater detail in the following paragraphs.

CREW PERFORMANCE MEASURES

NAVIGATION STABILIZATION. This task, a coordinated effort by the TACCO, Navigator, and Patrol Pilot in Command (PPC) is an important prerequisite to successful completion of the localization and attack mission phases. Stabilization of the navigation systems (Nav Stab) establishes an accurate North/South orientation or relative bearing. This relative bearing is maintained during subsequent operations by calculating buoy drift rates. A successful Nav Stab must be accomplished if the crew is to be able to maintain a valid match between the electronic world, used by the TACCO for problem resolution, and the real world. An accuracy measure was obtained on this activity which reflected the degree of success with which the crew established the real world position and drift rate.

SEARCH PHASE. The crew is responsible for detecting, locating, and identifying targets of interest. During the search phase of the ASW mission, buoy patterns, ECM triangulation, or radar run-ins can be used, but buoy patterns consistently receive the greatest emphasis throughout the five WST sessions. Therefore, the crew members primarily measured by Search Accuracy and Efficiency scores include the TACCO, Navigator, Jezebel operator and PPC.* The search phase is generally concluded by the dropping of a datum buoy to mark the target's estimated position. Accuracy scores for this phase were based on the difference between the estimated and actual target position. Efficiency scores were derived from the time taken to complete this phase.

LOCALIZATION PHASE. During localization the ASW crew may employ any, or all, of several procedures and equipments to refine their estimate of the position and operating parameters of the target. The tactics that can be

*It should be noted that the pilot measures obtained in the ASW section of the trainer are meaningless The pilot is seated at a console with only those controls needed to maintain heading, airspeed, and altitude. These controls in no way represent the actual controls required to accomplish piloting tasks. In effect, the pilot's role in the ASW section of the trainer is primarily to learn the appropriate voice and crew coordination procedures.

employed are: CODAR, Julie, Active Buoy, and MAD. The CODAR pattern is usually the first tactic employed followed by a Julie or Active Buoy pattern. Magnetic anomalie detection (MAD) procedures may be employed at any time, but they usually accompany or follow the Active pattern. The Localization Efficiency measure described the duration of the CODAR pattern and assessed the performance of the TACCO, Navigator, and Jezebel operator. Accuracy scores were derived from the difference existing in the distance between the target's actualposition and the marker buoy position or the weapons store drop position, whichever was appropriate.

ATTACK PHASE. For measurement purposes, the attack phase was considered to begin when entry into a Julie or Active Buoy pattern occurred, and to end with a successful kill or problem termination. Efficiency measures were derived from this time interval. Attack accuracy measures describe the deviation between weapons stores dropped and the criterion distance from the target.

INDIVIDUAL PERFORMANCE MEASURES

NAVIGATOR. During the course of the ASW mission, the Navigator performs both a computational and a bookkeeping function. As directed by the TACCO, he develops a hardcopy trace of target position, heading, speed, etc., based on data inputs from the other crew members. This dead reckoning trace (DRT) provides the TACCO with one criterion on which to prosecute the mission. In addition, the Navigator is responsible for documenting the mission in his Navigator's Log.

One facet of Navigator proficiency is his ability to keep abreast of and record data inputs he receives during each phase of the mission. To score Navigator proficiency, items he processed on his DRT and log were compared with the stimuli it could be assumed he received from each of the other ASW crew positions. A percentage score was computed which described the accuracy and completeness of his annotations.

JEZEBEL OPERATOR. During the search and localization phases of the ASW mission, the Jezebel operator participates in LOFAR search and CODAR localization. During both of these activities he is responsible for recognizing, interpreting, reporting, and annotating sensor data and other stimuli appearing on his synchronization chart. At the conclusion of each trainer session, the synchronization charts were scored by noting the accuracy and completness of the mission annotations. The operator's score was the percentage of possible annotations correctly accomplished by the operator.

JULIE/ECM OPERATOR. During the ASW mission, the Julie/ECM operator serves two functions. The first occurs during the search phase wherein he monitors and reports electronic signals emanating from suspected targets. This function is addressed very infrequently during the five trainer sessions. The second function occurs during Julie localization wherein the operator monitors and annotates a paper tape on which target returns are traced. In conjunction with his Julie duties, the operator also monitors and annotates taped responses resulting from Active Buoy detonations. Here he is serving as a backup to the AQA-1 Operator. The student's annotated tapes were reviewed by instructor personnel at the conclusion of each session in which he performed. The resulting Julie score was the percent of possible annotations correctly made by the student.

RADAR/MAD OPERATOR. This position is responsible for operating the radar and MAD equipments as directed by the TACCO. The MAD gear is used more frequently across the five WST sessions than the radar and provided a better means to obtain evaluative measurements. During MAD operations, the student is responsible for monitoring, interpreting, reporting, and annotating the signals appearing on the MAD tape. The student's score was the percent of possible annotations correctly accomplished.

DATA COLLECTION METHODS. The evaluation data were collected by Bunker Ramo personnel, assisted by WST instructors. Information for the team measurement data were obtained by monitoring the crew communications, student and instructor extra-channel communications, the mission plot retained on the WST optical pattern display, target to buoy distances, and digital readouts located at the instructor station. Annotation data were scored by Navy instructor personnel to ensure the necessary technical understanding and expert judgment required for completing the operator tasks at each position. These data were collected for two student classes in order to increase the overall N.

DATA ANALYSIS METHODS. Graphic analysis was selected to describe the effects of repeated use of the trainer on student performance levels. This method was deemed the most appropriate because (1) the aspects of performance measured were ones practiced more than once by the students during the training program, and (2) the sample sizes were generally too small to be satisfactorily evaluated with quantitative statistical methods. Two other factors were also expected to affect performance levels: individual and team differences, and WST problem differences. These factors were controlled to the extent possible.

Individual and crew differences were controlled by using repeated measures across the five WST sessions for each of the measures of student performance (the one exception to this will be noted in the Results section). Fairly complete control of individual and crew differences was possible for data collected on the first class because accurate information on crew member identification was available. During data collection for the second class, the instructors did not always maintain an accurate record of which team member was being trained at a position during each WST session. From a careful examination of the data collection sheets, it appeared that if more than one student for any one position was included on a crew, say crew M, then crew M(1) performed on WSTs 1, 3, and 5, while crew M(2) performed on WSTs 2 and 4.

To ensure that WST instructors employed a standardized set of instructions during the evaluation, the effects of problem variations on study goals were discussed with instructor personnel. The instructors were requested before and during the study to adhere to the WST syllabus, and ensure that the initial problem condition for any particular WST (e.g., number of targets, sea and air environmental conditions) was the same for all crews. Data descriptive of problem and environmental conditions were collected throughout each WST session. These descriptions were reviewed for each set of measures for each of the five WST sessions to ensure comparable data.

STUDY ONE RESULTS

The empirical results of Study One are discussed and presented graphically in the pages that follow. Both crew and individual performance curves support the learning hypothesis. A trend toward improved performance as a function of repeated trainer use was found in all cases.

The organization of the data sample was such that it was feasible to use the independent variable axis to describe WST session number, thus permitting presentation of the data within a training schedule and program context. It did not appear that any one of the individual WST sessions had any remarkable or consistent effects on performance over and beyond the effects that could be expected to result from repeated performance.

CREW PERFORMANCE

NAVIGATION STABILIZATION ACCURACY The performance curves presented in figure 1 indicate a consistent tendency toward improved Nav Stab Accuracy as the crews progress through their training program. It will be noted that two performance curves appear in this and most of the subsequent figures. There are no distinctions between these figures other than that they represent unique sets of crews (one set of 10 crews and another set of 2 crews appear in figure 1). Two curves were usually necessary to ensure repeated measures on each performance curve across the WST sessions. It is of interest to observe that although there is considerable difference between the initial performance levels displayed by the two curves, these differerces are minimal for the second Nav Stab performances. This is probably a direct result of the fact that some crews exhibited procedural and coordination problems during the first attempt at Nav Stab, which were subsequently corrected by instruction and practice. It is suggested that both of the crews performing their initial Nav Stab on WST 2 had procedural and/or coordination problems.

SEARCH PHASE ACCURACY AND EFFICIENCY. The accuracy and efficiency of search phase performance as the crews progressed through training is described in figures 2 and 3. Again, a consistent trend toward improved performance can be observed. The slope differences between the curves in Figure 3 are interesting and may suggest that amount of training transfer for this performance criterion was affected by duration of the time interval between performances. The crew Ns are too small, however, to be more than suggestive.

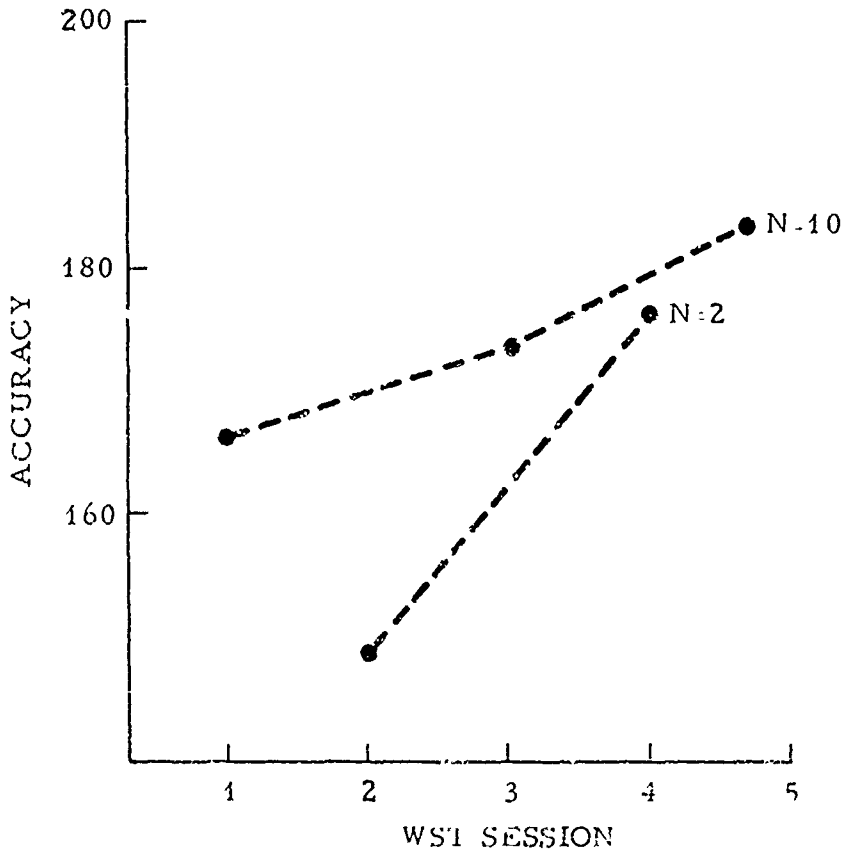


Figure 1. Crew: Navigation Stabilization Accuracy

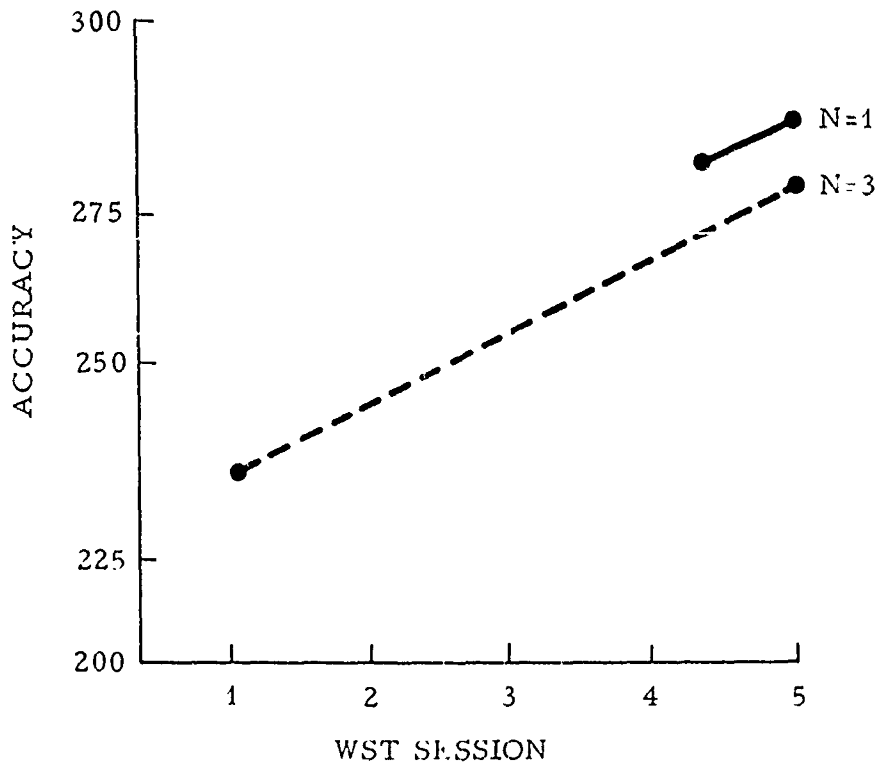


Figure 2. Crew: Search Phase Accuracy

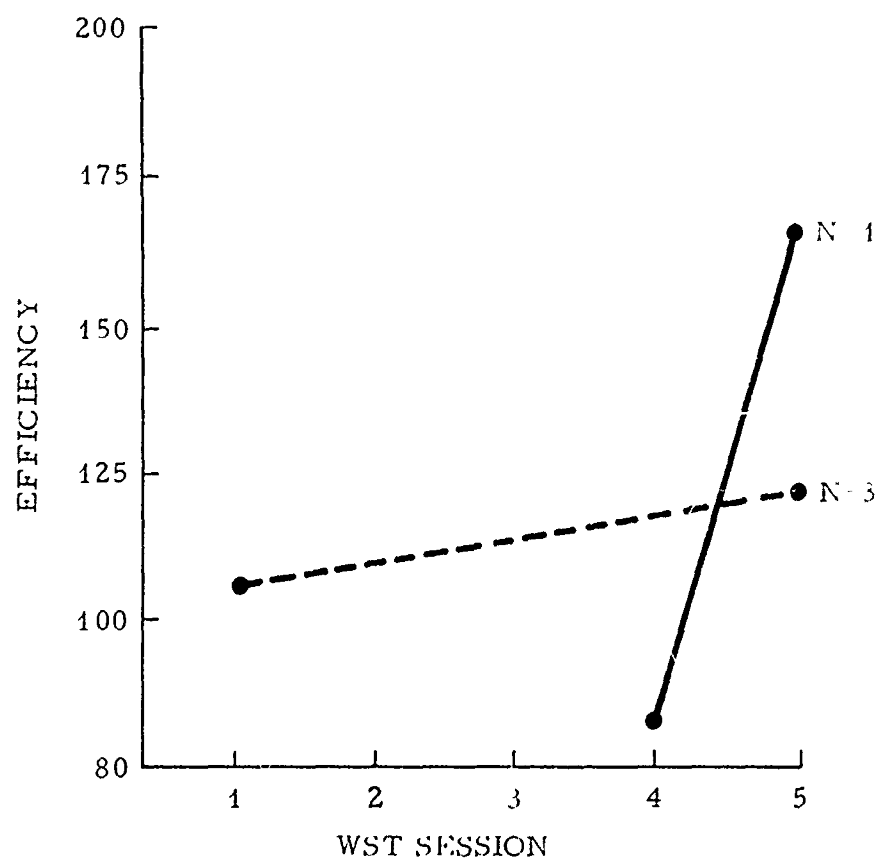


Figure 3. Crew: Search Phase Efficiency

LOCALIZATION PHASE ACCURACY AND EFFICIENCY. Figures 4 and 5 describe accuracy and efficiency changes in crew performance during the localization phase. The evidence indicates that although performance accuracy may be poorer for the first localization phase performed, it quickly tends to reach, and remain near the values of 275 and 280. Unfortunately, the accuracy curve for N = 4 could not be described for WST 2 because of the incomplete set of repeated measures data. In can be said, however, that those crews initially performing at a lower level all improved to the extent of fluctuating within the above-mentioned interval.

Both localization phase efficiency curves indicated performance improvement as a function of repeated trainer use. Again, the learning hypothesis appears to be supported.

ATTACK PHASE ACCURACY AND EFFICIENCY. Curves describing crew performance accuracy and efficiency during the attack phase are presented in figures 6 and 7. When and how the attack phase is performed during training is a function of not only syllabus requirements, but also the manner in which any particular ASW mission progresses and the crew's training needs are perceived by instructor personnel. As a result, an adequate sample of comparable repeated measures could not be obtained for this phase. Figures 6 and 7 provide the best available estimates of team performance during WST sessions 3, 4, and 5 and appear to support the learning hypothesis.

INDIVIDUAL PERFORMANCE MEASURES

NAVIGATOR ANNOTATION ACCURACY AND COMPLETENESS. Performance curves describing the Navigator's ability to correctly process all the information inputs he receives during the mission are presented in figure 8. It will be observed that the curves display a consistent tendency for improved performance in WSTs 3, 4, and 5, as compared to the first two WST sessions. It appears that the Navigator's initial ability to process information inputs is improved by repeated performance.

JEZEBEL OPERATOR ANNOTATION ACCURACY AND COMPLETENESS. Figure 9 describes the changes in Jezebel Operator capability to correctly and completely annotate the information appearing on his synchronization chart during WST training. Again, the curves support the learning hypothesis. The differences between the curves with respect to WSTs 1 and 2 appear to have resulted from the effects of chance on small sized samples of students with varying initial capabilities.

JULIE/ECM OPERATOR ANNOTATION ACCURACY AND COMPLETENESS. The change in Julie/ECM annotation proficiency over WSTS 3 and 5 is described in figure 10. The change is a positive one and supports the hypothesis that performance improves as a function of repeated performance in the trainer.

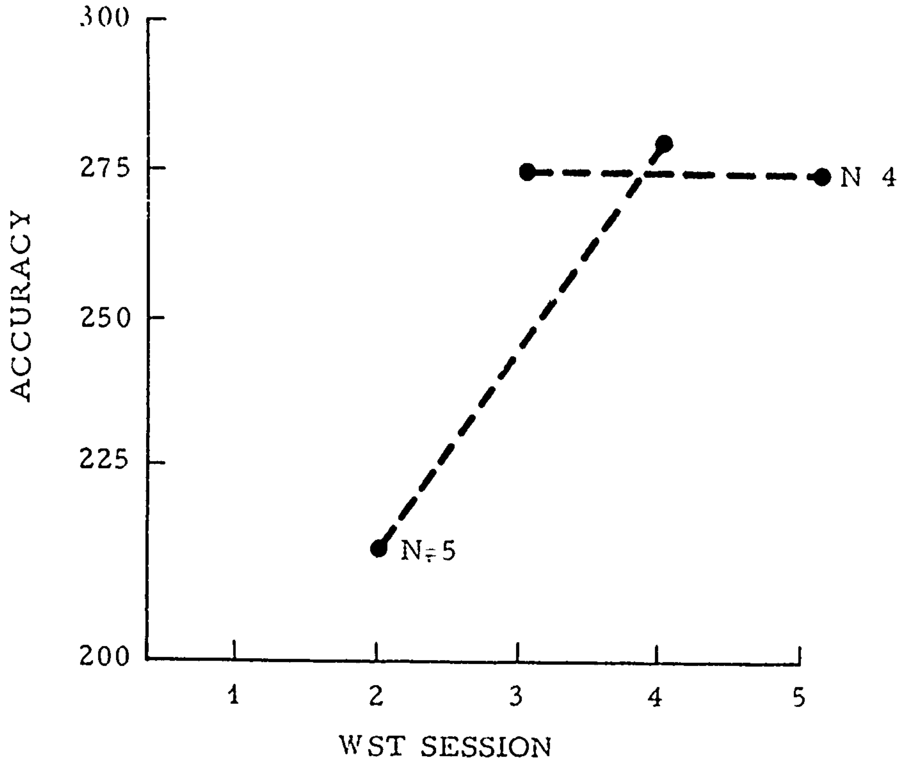


Figure 4. Crew: Localization Phase Accuracy

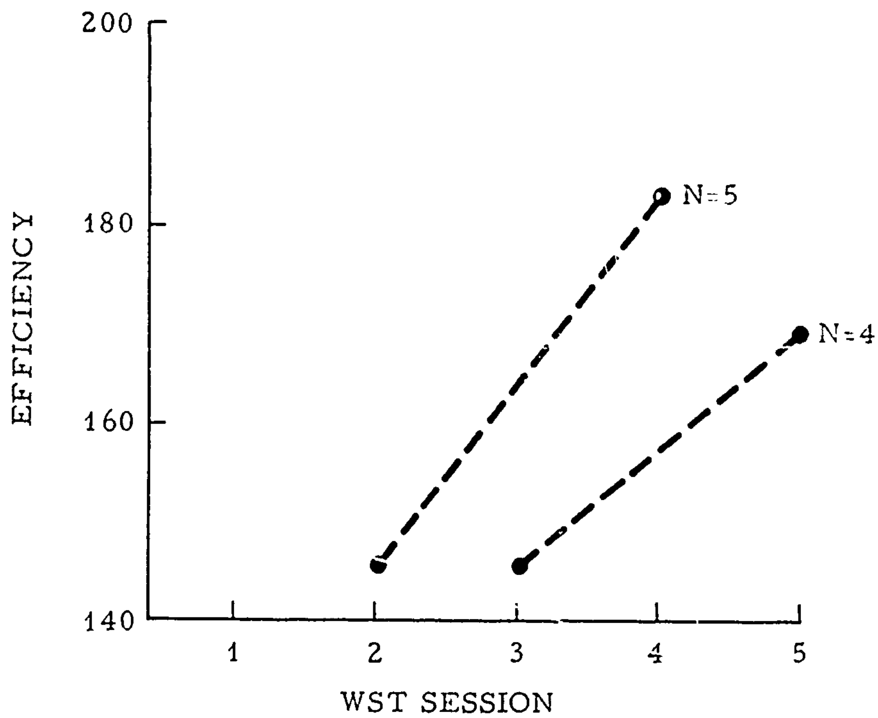


Figure 5. Crew: Localization Phase Efficiency

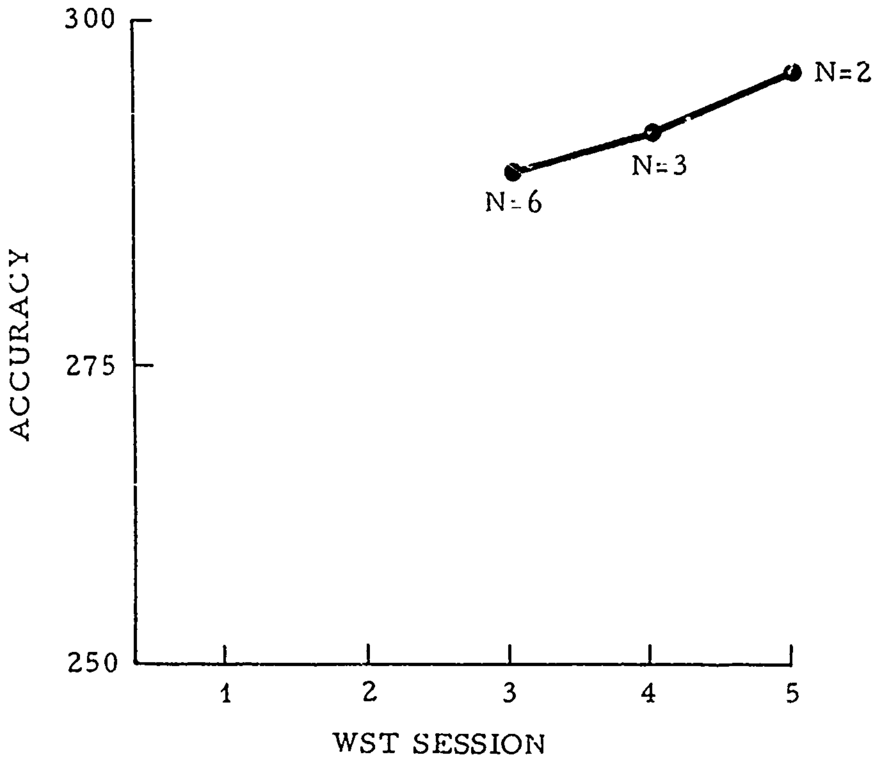


Figure 6. Crew: Attack Phase Accuracy

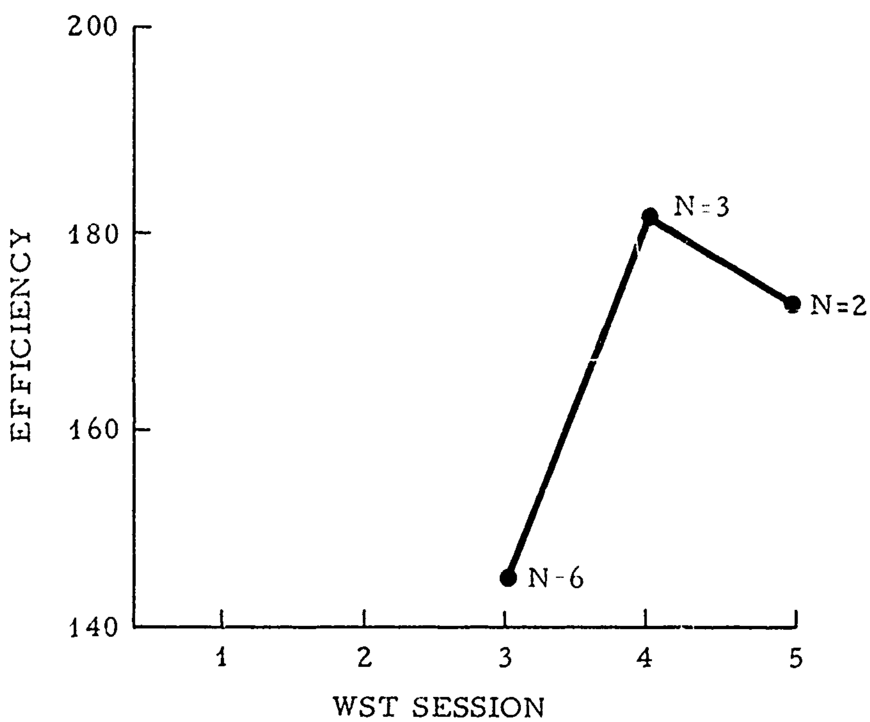


Figure 7. Crew: Attack Phase Efficiency

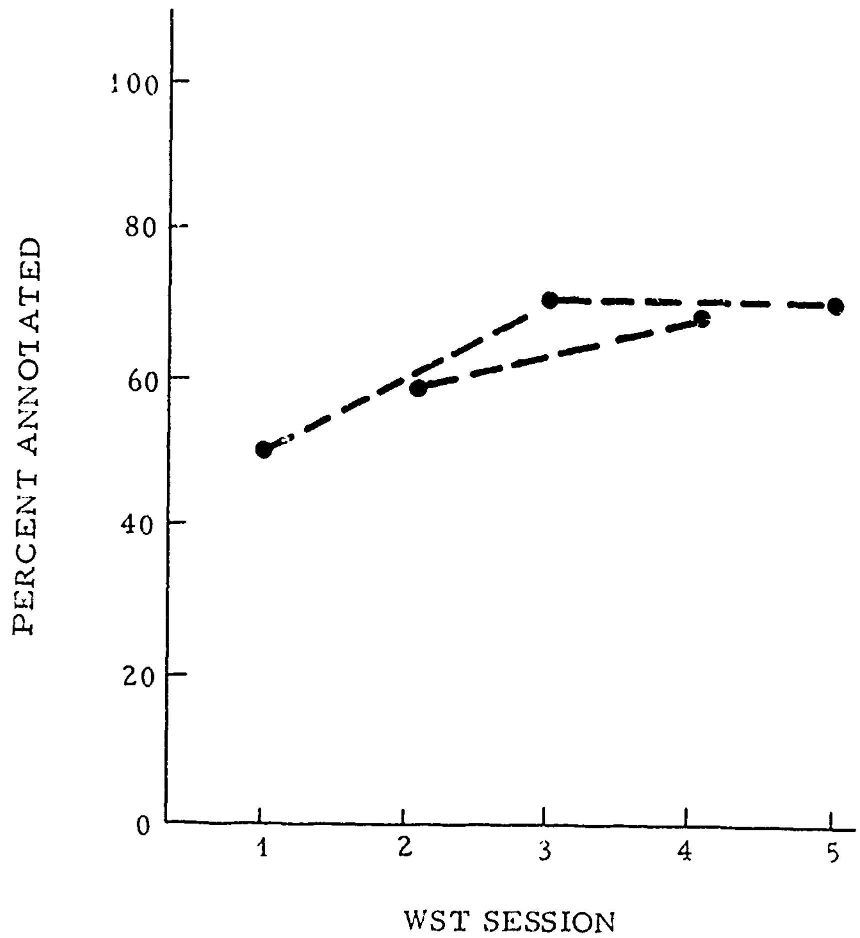


Figure 8. Individual: Navigator Annotation Accuracy and Completeness

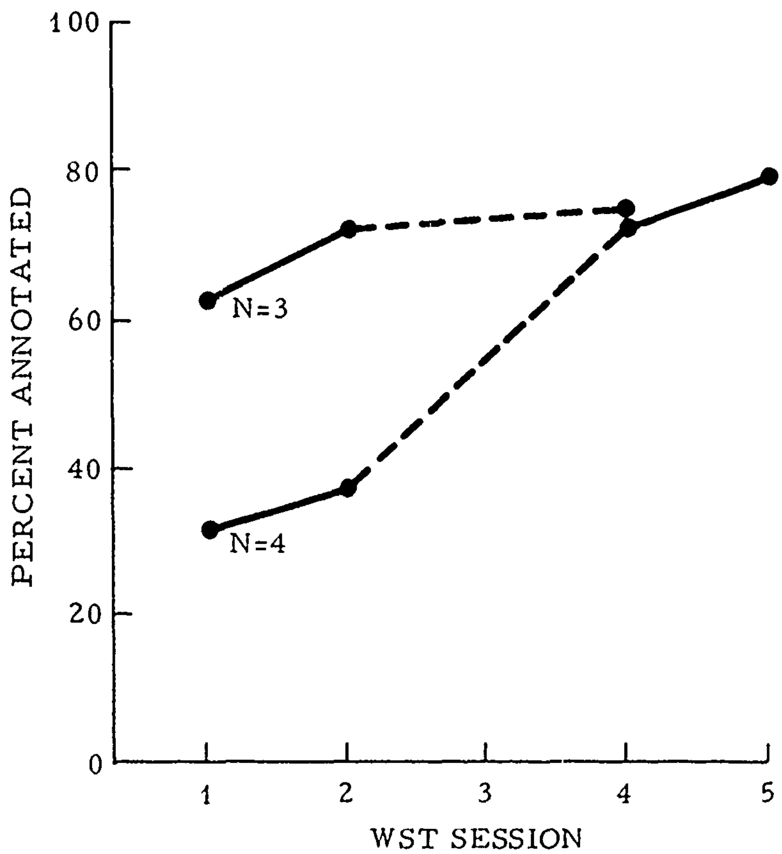


Figure 9. Individual: Jezebel Operator Annotation Accuracy and Completeness

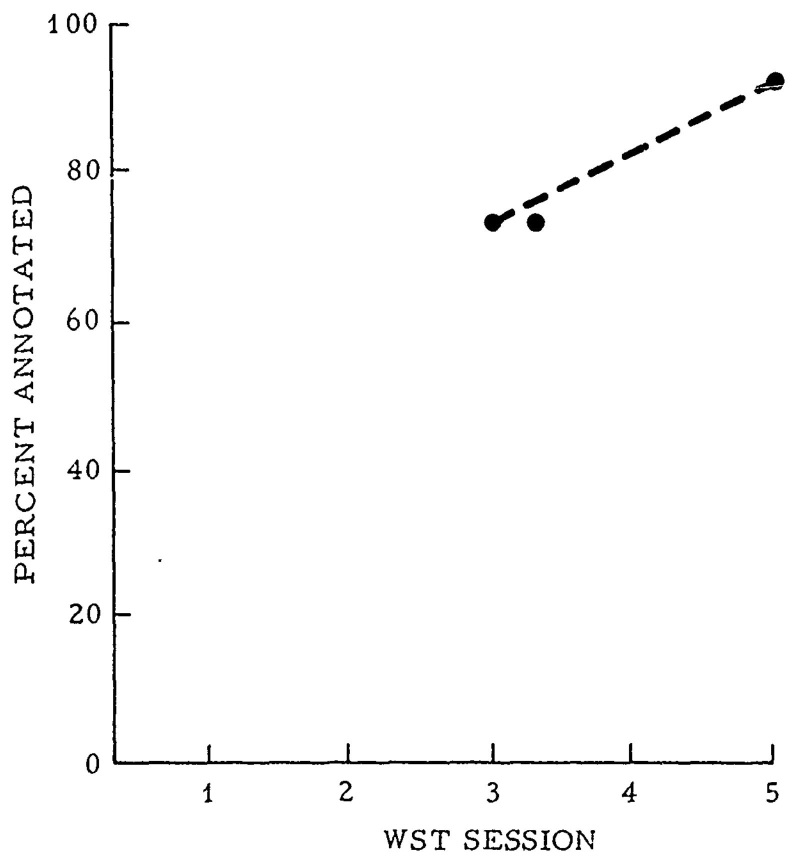


Figure 10. Individual: Julie/ECM Operator Annotation Accuracy and Completeness (N = 6)

RADAR/MAD OPERATOR ANNOTATION ACCURACY AND COMPLETENESS. Proficiency in accurately and completely annotating the MAD tape as a function of WST session number is described in figure 11. Although the small student N allows only a very tentative evaluation, it again appears that repeated use of the trainer benefits performance of this task.

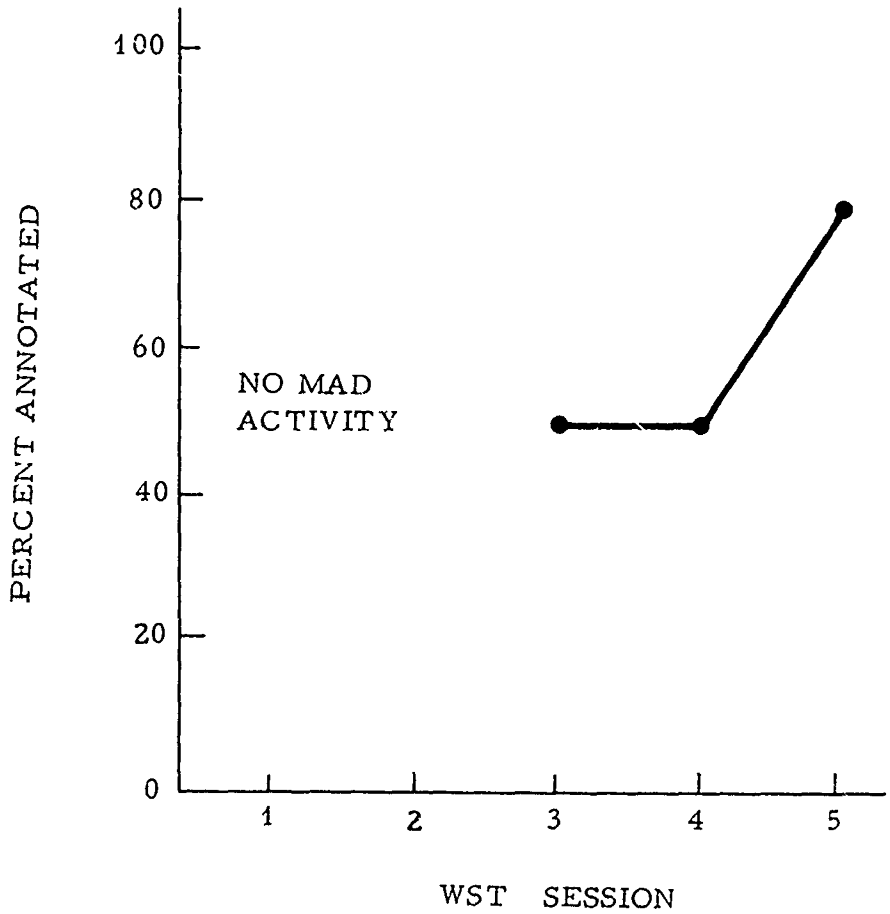


Figure 11. Individual: Radar/MAD Operator Annotation Accuracy and Completeness (N = 2)

SECTION III

EXPERIMENT TWO

INTRODUCTION

In the second experiment in this series, the data collection effort was extended to the airborne environment. The purpose of this second study was to demonstrate the extent to which simulator training transferred to the inflight ASW training environment. An ideal experimental design for this second effort would have been to provide simulator training to one group of subjects, not provide it to a second group, train both groups in the airborne environment, and later check the performance of both the experimental and control group in their operational ASW squadrons. Although the experimenters were allowed to modify the training schedule slightly, they were unable to achieve the ideal experimental design. Instead, an intermediate approach was authorized by the training squadron. In the authorized approach, the experimental procedure discussed above was to be partly applied, in that at least two groups of subjects were to be introduced (excluding the last training session) to a problem in the airborne environment first. They were to then proceed to the simulator. This is the reverse of the normal training procedure. Due to weather problems and class size, the design would not be employed past the first training session.

In the planning stage of study design, the intent was to test airborne ASW performance against actual submarine targets. Unfortunately, the task of scheduling submarines to coincide with training flight timetables proved to be out of the question. Thus, airborne performance was tested as the ASW operators worked against targets of opportunity which generally proved to be surface ships from various merchant fleets. Obviously, the acoustical returns from such vessels would be less than optimum for training submarine procedures.

SUBJECT POPULATION

Data were collected on two classes of students composed of 4 and 7 crews, respectively. Again, as in Study One, none of the crews in either class were constituted of one student for each position. The range and average number of students per position per crew appear in table 2.

EXPERIMENTAL DESIGN

Squadron training schedules were modified to provide experimental and control student groups for a limited transfer of training evaluation. The schedule for Wings A and B of two classes were as follows:

Class One: Wing A: WST 1/ASW 1/WST 2/ASW 2/WST 3/ASW 3/WST 4 ASW 4/WST 5/ASW 5

Wing B: ASW 1/WST 1/ASW 2/WST 2/WST 3/ASW 3/WST 4/ASW 4/WST 5/ASW 5

TABLE 2. STUDY TWO DESCRIPTION

Position	First Class	Second Class	Total Number of Students
TACCO	1.8 1-2	1.6 1-2	18
Navigator	2.0 2	2.0 1-3	22
Jezebel	1.3 0-3	0.7 0-1	10
Julie/ECM	0.0	0.0	0
Radar/MAD	1.3 1-2	0.3 0-1	7

Class Two: Wing A: WST 1/WST 2/ASW 1/WST 3/ASW 2/WST 4/ASW 3/ASW 4/WST 5/ASW 5

Wing B: ASW 1/WST 1/WST 2/ASW 2/WST 3/ASW 3/WST 4/ASW 4/ASW 5/WST 5

The training schedule represented by Wing A of Class One is the normal training schedule. The training schedule for Wing A of Class Two was to have been the normal schedule but was modified to accommodate a hurricane. For the particular transfer of training hypothesis evaluated in this study, both A Wings were considered members of the same group. B Wings represent the training schedule modifications permitted for study purposes.

Two transfers of training hypotheses were considered: (1) that prior WST training in the device would positively affect inflight ASW performance and, conversely, (2) that prior ASW inflight training would positively affect subsequent WST performance. Wings A versus B constituted the experimental and control groups for these hypotheses, which can be stated as follows:

a. Wings A will perform ASW 1 better than Wings B

b. Wings B will perform WST 1 better than Wings A

It will be noted that the training schedule for Wing B of Class Two was also modified to permit an evaluation of transfer from ASW to WST 5 and vice versa. Unfortunately, insufficient comparable data were obtained to evaluate these hypotheses.

As Classes One and Two represented independent samples of students, the possible contribution of a class factor was evaluated statistically whenever sample sizes permitted.

The above study designs can be summarized as follows. The design for the transfer of training hypotheses was a 2 x 2 factorial design using independent samples. The first factor consisted of the experimental and control groups, Wings A and B, where the experimental group was that Wing which had had prior training in the alternative training environment and the control group was that Wing which had not had any prior training. The second factor, when included, was Classes One and Two.

The WST and ASW learning hypotheses were evaluated with a repeated measures design for the factor of Training Environment.

Since the results obtained in Study One did not indicate that individual WST sessions (e.g., WST 3) had distinctive or consistent effects on performance variability, it was decided to consider analysis and presentation of student performance data in terms of the number of sessions performed rather than WST session number. Further, the varying number of students included in each crew for each position made it necessary to display student performance data against an abscissa defined in this manner in order to depict possible learning effects.

STUDY MEASURES

Several objective measures of crew and individual performance were collected in Study Two which were quite similar to those collected in Study One and shall be considered identical in terms of general definition. The differences are primarily the result of different measurement procedures (procedures appropriate for both training environments were used in Study Two) which led to somewhat different sets of mission phase activities being assessed in the two studies, even though there was considerable overlap between the sets. Full measure definitions or distinctive Study Two measure characteristics are given below only where the general definition has been essentially changed. Appendix B includes the criterion scoring forms employed in Study One. Appendix C contains those used in Study Two.

A new objective measure of performance was collected on the mission phases and, where feasible, on the individual positions. This measure assessed the team and the operators procedural proficiency in terms of complete and correct performance. Procedural omissions and errors represented the difference between a 100% procedures score and the percent score given.

In addition to objective performance measures, data collected on an evaluative set of measures were used to provide a basis for interpreting the objective data and for recommending modifications and/or courses of action to improve device utility and effectiveness. These evaluative training device measures were collected by use of a questionnaire (see Appendix D) which was completed by instructor personnel for their particular position (e.g., TACCO/Navigator instructors versus Radar/MAD instructors). Instructors answered questions with reference to only their own position or the crew as a whole and specified when they were giving the latter type of answer. The questions related to specific characteristics of the training device and their relationship to training objectives, learning phases, and equipment and operator functions.

CREW PERFORMANCE MEASURES

NAVIGATION STABILIZATION. Two measures of Nav Stab performance were obtained: procedures and accuracy. A crew's procedures score was the percentage of procedures that should have been performed correctly. Although the accuracy values obtained in Studies One and Two are not directly comparable, because of a change in emphasis on Nav Stab methods utilized, the general definition of the Nav Stab accuracy measure remains the same.

SEARCH PHASE. Three measures of crew search phase performance were obtained: procedures, accuracy, and efficiency. The procedures score was again the percentage of procedures correctly performed and not erroneously omitted. The accuracy and efficiency measure definitions remain essentially the same.

CREW LOCALIZATION PHASE. A measure of localization phase procedures was obtained and is defined as above. Insufficient data were collected on localization accuracy and efficiency to permit evaluations of student performance differences or changes.

INDIVIDUAL PERFORMANCE MEASURES

NAVIGATOR. The Navigator measure obtained in Study Two was a total score which assessed not only the accuracy and completeness of DRT and log annotations, but also adherence to procedures (e.g., periodicity of stabilization store mark on tops). The measures applied were those normally used by the training squadron for Navigator assessment. The total score represents the sum of three weighted percentages (procedures, tactical log, tactical chart) where the maximum possible component and total scores are 100.

JEZEBEL OPERATOR. In both Studies One and Two, the Jezebel operator's score was the percentage of possible synchronization chart annotations correctly made by the operator, based on instructor scoring of the chart. Because it was not possible to have the charts from both studies evaluated by the same instructor personnel, the scores obtained in the two studies should not be considered completely comparable.

JULIE/ECM OPERATOR. There were no Julie/ECM students participating in the second study.

RADAR/MAD OPERATOR Measures collected on this position during the second study included: radar log entries, percent complete; MAD procedures, percent correctly performed; and MAD tape annotations, percent correctly made. Again, because it was not possible to have the MAD tapes from both studies evaluated by the same instructor personnel, the scores obtained in the two studies should not be considered directly comparable.

DATA COLLECTION METHODS. The data were collected by instructor personnel using forms especially developed for each of the individual sensor stations and for the team as a whole. The primary emphasis of crew measures was on the TACCO/Navigator/PPC Subteam. Additional mission descriptive data were collected in the device WST sessions by a Bunker Ramo project member, assisted by device personnel. Sensor records, charts, and logs were scored by instructor personnel to ensure the technical cognizance and judgment required for each position.

DATA ANALYSIS METHODS. Analysis of variance was used to evaluate the transfer of training and learning hypotheses where there was sufficient data to do so. T-test or two-factor methods, for independent or repeated measures, for equal or unequal Ns, were used as appropriate. Graphic analysis was performed in all cases to evaluate and display student performance variations as a function of repeated performance.

STUDY TWO RESULTS. This section of the report presents the objective performance data collected in Study Two. The results of statistical and graphic analyses are presented and evaluated within the observed training context. A number of the performance curves were based on incomplete replications of the sample population. Considerable data was lost due to incomplete entries on data collection forms. These scoring deletions occurred when the instructors elected to ignore data collection in favor of providing the student with directions. An effort was made to base the curves on the most complete set of replications, or repeated measures, possible (e.g., if the only measure obtained on an operator was during his fourth WST performance, this datum did not contribute to the estimation of WST 4 performance level).

In general, it was found that aircraft ASW performances displayed more consistent learning trends and higher levels of performance than did the trainer WST performances and that only hypotheses of transfer from the trainer to the aircraft were supported. This was not considered surprising considering the following: (1) the training device probably provides a better instructional environment (due to lower noise levels and ability to freeze the problem for discussion purposes), and (2) the compositions of most of the student crews during this study (e.g., Crew M with three TACCOs, two Navigators, two PPCs, one Jezebel operator, and no radar operators; Crew N with one TACCO, three Navigators, two PPCs, three Jezebel operators, and one radar operator; etc.) necessitated training two or more teams per crew within a training program and time schedule designed for one person per ASW crew position. The latter situation forced the instructors to trade-off students so as to provide all students with some exposure. This was probably better accomplished in the instructional environment of the trainer. Even so, such a training regimen could be expected to fall short of providing consistent or optimum learning effects.

CREW PERFORMANCE MEASURES

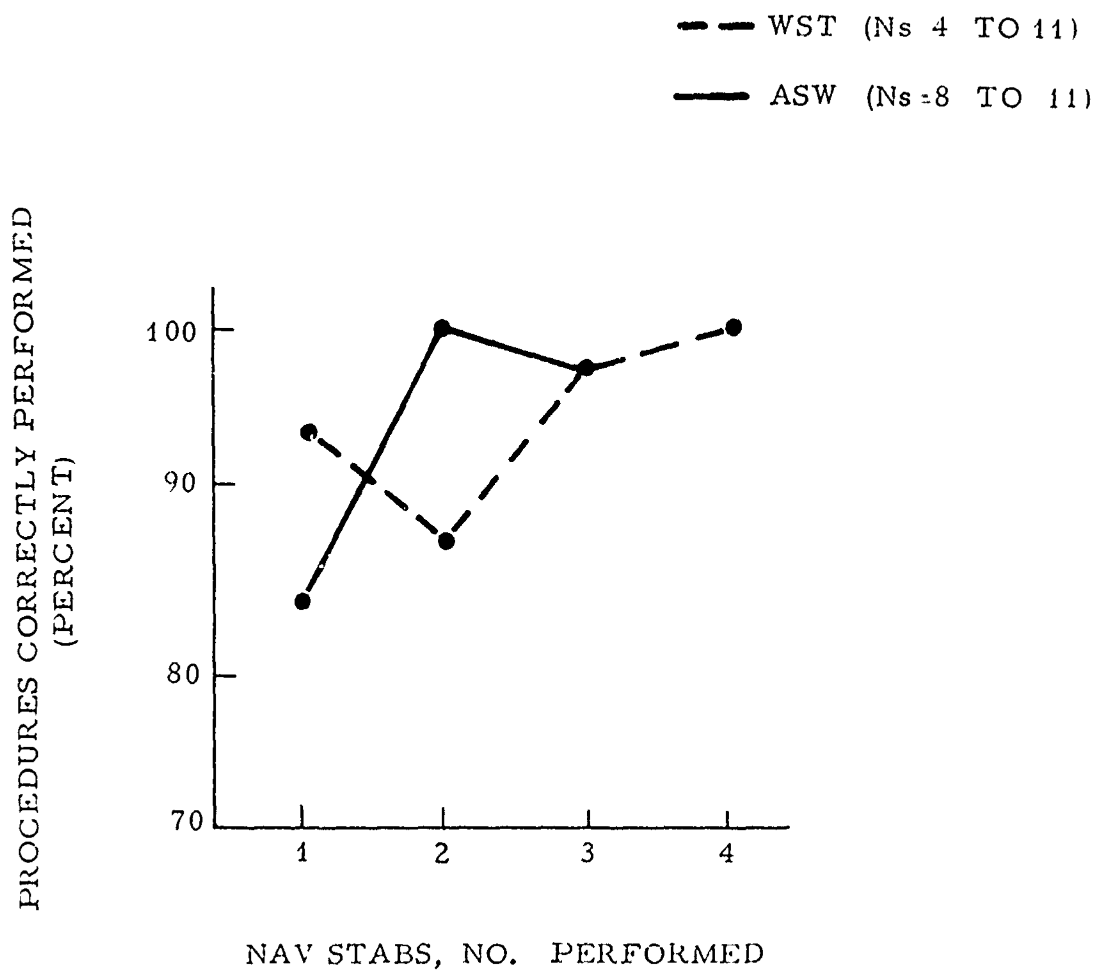
NAVIGATION STABILIZATION PROCEDURES AND ACCURACY. Figure 12 describes WST and ASW Nav Stab Procedure performance trends based on what is best described as independent samples. Both the WST and ASW curves depict a general trend to improved performance. The average initial performance levels vary between 84 and 94%, while the second and third ASW and third and fourth WST performances vary between averages of 98 and 100% procedurally correct.

Although there was insufficient repeated measures data to statistically test the WST performance change, the results of testing the ASW performance changes between the first and second Nav Stab performance were significant at the 0.01 level (see table 3); i.e., Nav Stab procedural performance did improve significantly in the ASW training environment. There was also an interaction trend between training and class ($p < 0.10$) which resulted from the differing initial performance levels between the two classes (74% versus 93%). The difference in initial performance levels could have resulted from many factors, including student and instructor differences. It is also possible that the difference could have resulted from modifications made in a prior systems training course. The class with an initial mean performance level of 93% had received the modified course.

The hypothesis that prior performance in the WST environment would benefit initial ASW performance was tested and a tendency, significant at $p < 0.10$ was found (see table 4). Despite the small cell Ns, the data trends were consistent. The mean initial ASW performance value for TACCO/Navigator teams who had performed a Nav Stab in the trainer first was 96%. The mean initial ASW performance value for students performing a Nav Stab for the first time was 85%.

Figure 13 describes WST and ASW Nav Stab Accuracy and is based on repeated measures. The individual Ns for the WST curve are 4, 4, 1, and 1 and 1 for Nav Stab performances 1, 2, 4, and 5, respectively. The first and second performance values for the one team providing samples of fourth and fifth WST Nav Stab performances are closely represented by the mean curve.

In Study One, the measure of Nav Stab Accuracy was an average of the several attempts to accurately stabilize the navigation system. The data obtained for that measure displayed a consistent learning trend during WST training (see figure 1). In Study Two, the obtainable measure of Nav Stab Accuracy was the final accuracy with which the system was stabilized. This difference in measure definition may be responsible for the different type of Nav Stab Accuracy performance curves obtained in Study Two because different aspects of behavior were being measured. The instructors intend to give primary emphasis to Nav Stab instruction the first time it is performed by the students. Consequently, if the initial attempts at system stabilization are not considered sufficiently accurate, the procedures may be repeated as necessary until reasonable accuracy is established. In subsequent sessions, the integration of Nav Stab into the mission context is emphasized. The average performance levels for the first and second WST and ASW performances presented in



NOTE: These curves represent best estimates, based on independent measures; i.e., data are not controlled witn respect to crew identity.

Figure 12. Crew: Navigation Stabilization Procedures

TABLE 3. ANALYSIS OF VARIANCE SUMMARY FOR ASW TRAINING EFFECTIVENESS FOR NAVIGATION STABILIZATION PROCEDURES

Source of Variation	SS	df	MS	F
Between Subjects A (Classes)	403.79	1	403.79	3.39
Subjects within groups	909.54	8	119.25	
Within Subjects B (ASW Nav Stabs)	1302.24	1	1302.24	11.47**
AB	403.70	1	403.70	3.55*
B x Subjects within groups	908.54	8	113.57	

*F 0.90 (1,8) = 3.46
**F 0.01 (1,8) = 11.3

TABLE 4. ANALYSIS OF VARIANCE SUMMARY FOR TRANSFER OF NAVIGATION STABILIZATION PROCEDURE WST TRAINING TO ASW TRAINING

	SS	df	MS	F
A (Classes)	162.89	1	162.89	2.60
B (Wings A, B)	266.25	1	266.25	4.25*
AB	25.08	1	25.08	0.40
Within Cell	500.80	8	62.60	

*F 0.90 (1,8) = 3.46

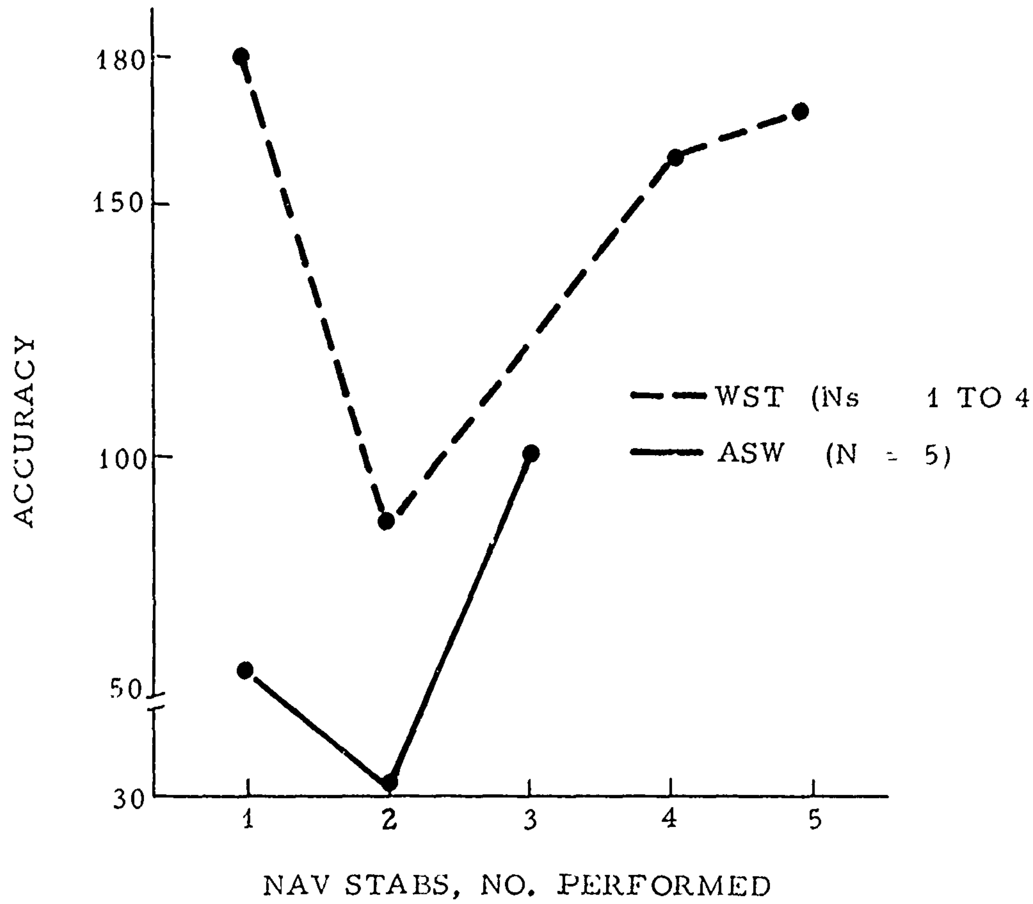


Figure 13. Crew: Navigation Stabilization Accuracy

figure 13 appear related to this change in emphasis. The first performance of Nav Stab, especially in the trainer (which offers the best opportunity for repeated attempts to accurately stabilize the system), tends to be considerably better than the second performances. Evidence of beneficial training effects are provided by improved subsequent performance levels which may indicate that the students are learning to integrate this activity into the mission context at more adequate levels of performance. This conclusion should be considered tentative, however, in that there was insufficient data to statistically test the change in WST performance levels and ASW performance changes were not found to be significant (see table 5). This lack of significance was anticipated in that ASW accuracy values tend to vary substantially as a function of equipment operating status variations (e.g., calibration status) and the sample size was quite small. No comment can be made on transfer of training effects as there was insufficient data to permit any type of evaluation.

SEARCH PHASE PROCEDURES, ACCURACY, AND EFFICIENCY. Changes in student procedural performance of the search phase are displayed in figure 14. The curves for both WST and ASW indicate a trend to improve procedural performance as a function of performance repetition. Statistical tests of the performance level change substantiate the apparent learning effects in that the difference between the first and second WST performance was found significant at $p < 0.10$, while the differences between the first and second ASW performances, the classes, and the ASW x Class interaction were all found significant at $p < 0.01$ (see tables 6 and 7). The class difference is interesting in that the interaction effect appears to have resulted from different initial performance levels and similar terminal levels, but again, these results could be explained by a number of factors including a possible difference in prior training. What is of primary importance is that the students did not initially perform all the search procedures correctly, but that they did learn to do so while in training. Whether or not there were any transfer of training effects could not be determined because of insufficient data.

It was extremely difficult to gather transfer data because of training crew configuration. The TACCO/Navigator instructors were especially faced with the problem of often having more than the one TACCO and one Navigator student per crew. Their program and schedule is designed for one of each. As a result, they generally treated the training device and the aircraft as equivalent training situations and traded off the students in position accordingly. Thus, if one TACCO/Navigator pair performed the first WST session, then a second TACCO/Navigator pair performed the first ASW session. For study purposes, it could not be said that the second TACCO/Navigator pair had not received <u>any</u> training because they had been present as over-the-shoulder, and sometimes interactive, observers of performance by the first team and the instruction given by the instructors. Consequently, the only data provided in these situations was the first performance by the first team of a crew; subsequent performances in the alternative training environment by a second team did not satisfy the requirements for either experimental or control group membership.

Insufficient data were collected on the measure of Search Phase Accuracy to permit an evaluation. No trends were evidenced by the sample obtained ($N = 3$ for two performance repetitions).

TABLE 5. ANALYSIS OF VARIANCE SUMMARY FOR ASW TRAINING EFFECTIVENESS FOR NAVIGATION STABILIZATION ACCURACY

Source of Variation	SS	df	MS	F
Between Subjects		4		
A (Classes)	524.34	1	524.34	---
Subjects Within Group	35223.25	3	11407.75	
Within Subjects		5		
B (ASW Nav Stabs)	466.99	1	466.99	---
AB	1702.64	1	1702.64	---
B x Subjects Within Group	19146.59	3	6382.20	

TABLE 6. ANALYSIS OF VARIANCE SUMMARY FOR WST TRAINING EFFECTIVENESS FOR SEARCH PHASE PROCEDURES

Source of Variation	SS	df	MS	F
Between Subjects				
A (Classes)	4.91	1	4.91	---
Subjects Within Groups	225.82	12	18.92	
Within Subjects				
B (WST Search Performances)	155.88	1	155.88	4.16*
AB	70.92	1	70.92	1.89
B x Subjects Within Groups	449.43	12	37.45	

*$F_{0.90}(1, 12) = 3.18$

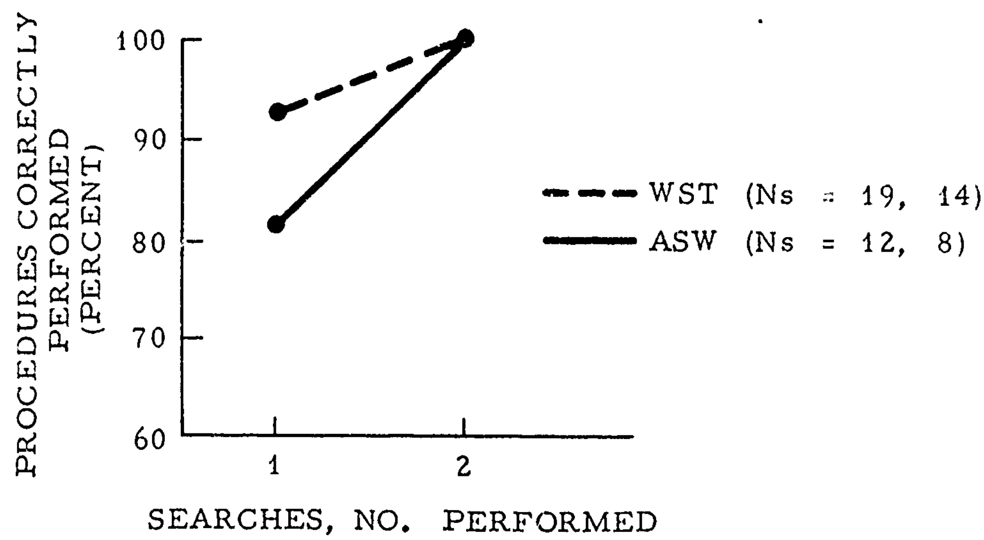


Figure 14. Team: Search Phase Procedures

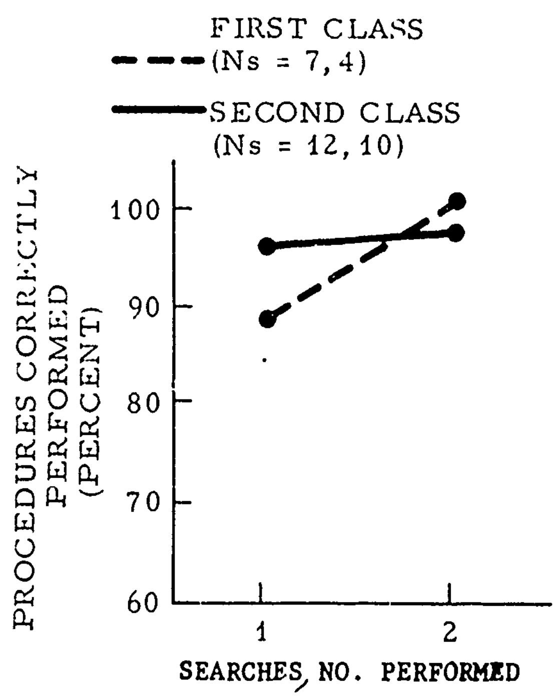


Figure 15. Class Differences in WST Performance of Search Procedures

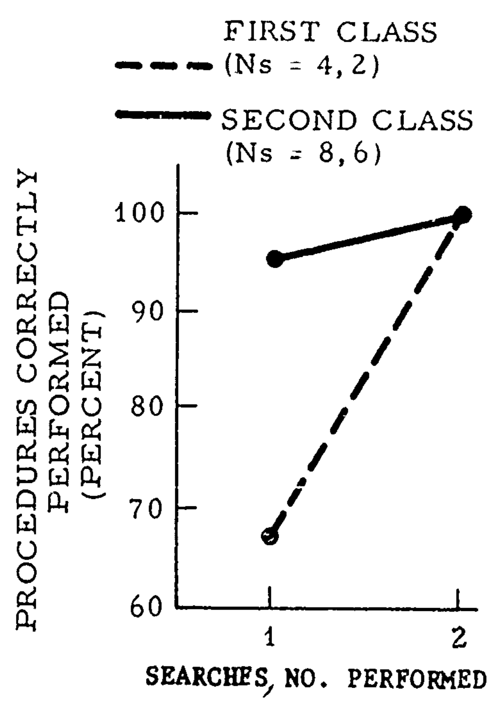


Figure 16. Class Differences in ASW Performance of Search Procedures

TABLE 7. ANALYSIS OF VARIANCE SUMMARY FOR ASW TRAINING EFFECTIVENESS FOR SEARCH PHASE PROCEDURES

Source of Variation	SS	df	MS	F
Between Subjects				
A (Classes)	1339.40	1	1339.40	29.69*
Subjects Within Groups	270.67	6	45.11	
Within Subjects				
B (ASW Search Performance)	2316.62	1	2316.62	51.35*
AB	1339.37	1	1339.37	29.69*
B x Subjects Within Groups	270.66	6	45.11	

*$F_{0.99}(1, 6) = 3.7$

The WST and ASW performance curves presented in figure 17 indicate poorer efficiency during the first Search Phase performed. Subsequent average performances appear to vary within the interval of 155 to 162. Examination of individual performances indicate that, indeed, this is the case. Many, but not all, searches conducted by student teams for the first time required a considerable amount of time.

Subsequent performances improved until the interval of 155 to 170 was reached, performance then varied within this interval probably as a function of situational factors affecting mission activities. It would appear, then, that Search Phase efficiency at least benefits from initial training. Insufficient data were available to statistically test this conclusion.

The transfer of training hypotheses could not be statistically evaluated again because of insufficient data, but it can be said that the available data (Ns - 1 to 5) support both hypotheses; that is, positive transfer of training from the device to the aircraft environment and vice versa.

LOCALIZATION PHASE PROCEDURES. Curves for Localization Phase procedural performance appear in figure 18. Neither these curves nor a statistical test of the WST curve nor inspection of the ASW data provide evidence of any consistent performance trends. The only apparent factor determining performance variance was that of class, again with the second

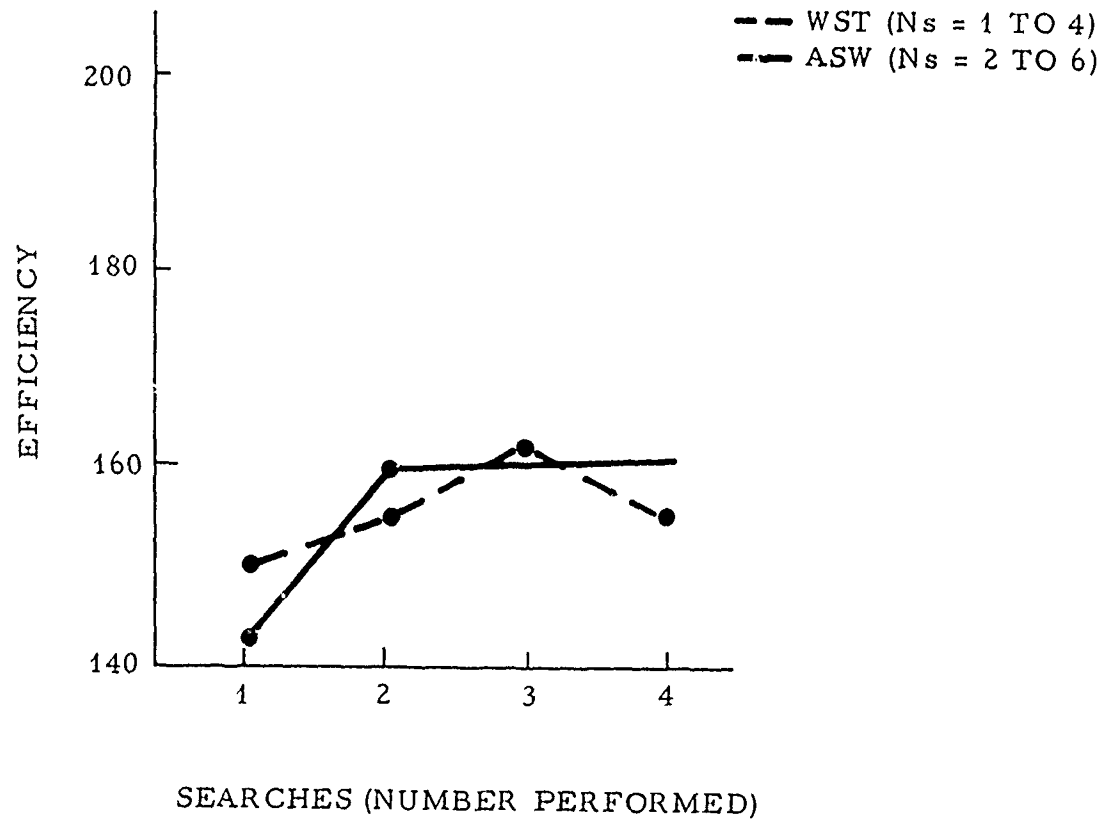
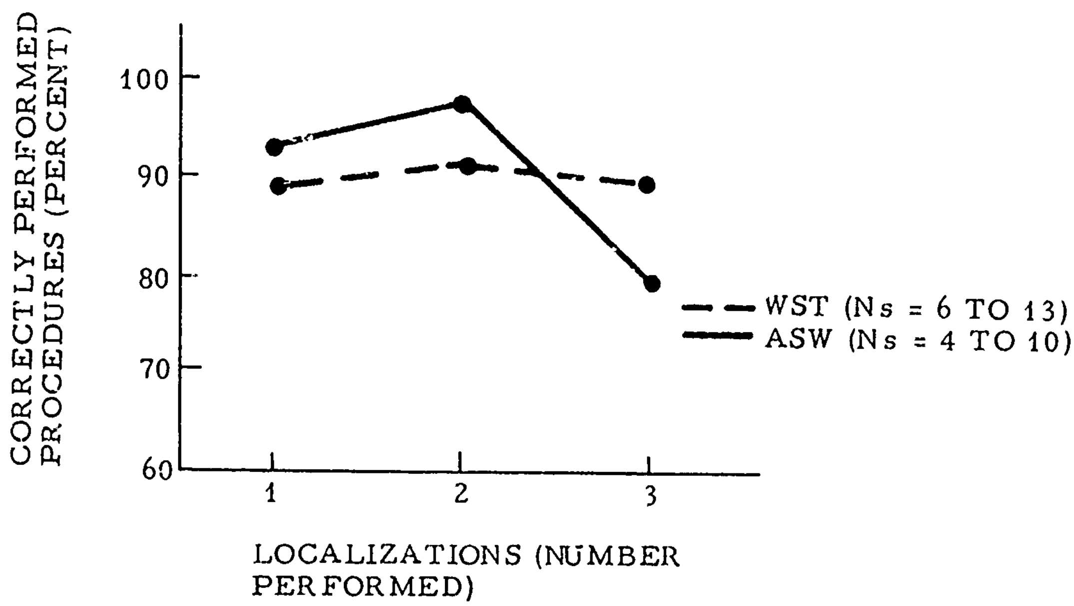


Figure 17. Crew: Search Phase Efficiency



NOTE: The WST curve is based on independent samples while the ASW curve is based on incomplete repeated measures.

Figure 18. Crew: Localization Phase Procedures

class performing at a higher level than the first class (see able 8). Insufficient data were available to analyze transfer of training effects. It can only be said that the data did not contradict these hypotheses.

TABLE 8. ANALYSIS OF VARIANCE SUMMARY FOR WST TRAINING EFFECTIVENESS FOR LOCALIZATION PHASE PROCEDURES

Source of Variation	SS	df	MS	F
Between Students				
A (Classes)	450.88	1	450.88	3.57*
Students Within Group	1137.12	9	126.35	
Within Students				
B (WST Localizations Performed)	27.96	1	27.96	---
AB	0.00	1	0.00	---
B x Students Within Groups	1359.49	9	151.05	

*F 0.90 (1, 9) = 3.36

It will be recalled that the first study provided indications of WST lea-ning effects for Localization Phase accuracy and efficiency. No analyzable data were obtained on these measures in the second study.

It can only be concluded from the above that the effectiveness of the training program and device for Localization Phase training has not yet been satisfactorily demonstrated empirically. Target localization can be realized by complex and alternative activities, the performance of which tends to be contingent on situational characteristics. Observations of crews in training in the device have led to the conclusion that student crews do learn the nature of the localization problem and do tend to improve their performance of localization activities. The inability to define a meaningful localization task measurement set for the two training environments which would provide consistent repeated measures precluded adequate empirical demonstration of the qualitative conclusion.

INDIVIDUAL PERFORMANCE SCORES

NAVIGATOR. Figure 19 presents the mean WST and ASW performance curves for the student navigators. The presence of more than one student navigator on many teams resulted in students frequently either performing some part of each session or sharing and trading off navigator functions during the sessions; particularly in the WST environment. As a result, the following two conditions existed: (1) it was possible to use the WST and ASW session number to define

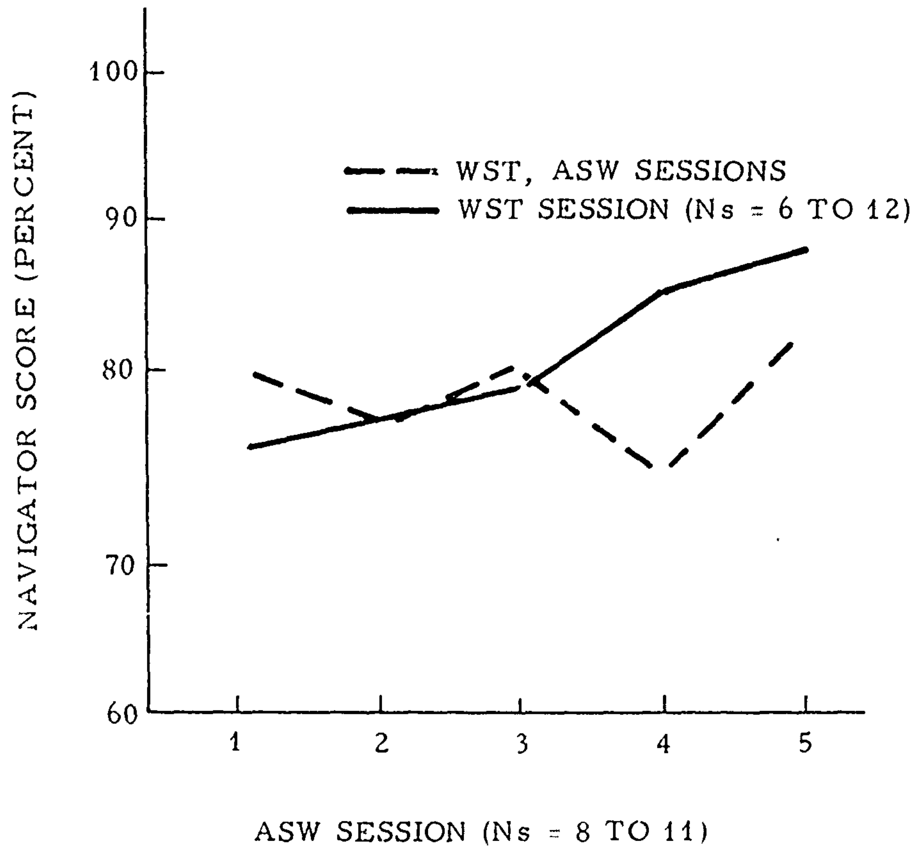


Figure 19. Individual: Navigator

the abscissa, and (2) to ensure repeated measures of comparable definition it was necessary to delete many of the available scores. Therefore, the performance curves can best be described as representing independent groups because of the repeated measure discontinuities.

The ASW performance curve displays a consistent trend toward improved performance during the training program. The WST curve on the other hand does not appear to display any consistent trend. Since there was a larger data sample available on this measure during the entire training program, it was possible to develop individual curves per class and per wing. This was done to evaluate possible effects of class and training schedule differences on navigator ASW and WST performance trends. (Class distinctions were maintained due to the possible impact of differences in a prior systems course.) These trends are presented in figures 20 and 21 and may provide a possible explanation for the curves in figure 19. The curves display one difference tendency which had been anticipated from analysis of data collected on other measures and another difference tendency which had been hypothesized. That is, the initial performance levels for the second class were higher in both the WST and ASW situation, and the wings receiving one or two WSTs prior to an ASW flight tended to perform better on both their fifth WST session, and more importantly, their fifth ASW flights.

Other variations between the curves in figures 20 and 21 were of interest in that they may correlate with observations of student behavior in the training device. It was observed that certain of the crews appeared to more readily accept the utility of sessions in the training device than did other crews. It is suggested that those crews receiving their initial one or two sessions in the WST may better accept the training device. It can be observed that these are the teams (Wing A) which evidence more consistently patterned curves, it can also be observed that Wing B of the second class provided the poorest average WST 5 performances, where WST 5 followed ASW 4 and 5 in sequence. Further, Wing B of the first class provided the poorest average ASW 3 performances, where ASW 3 followed WST 2 and 3 in sequence. The evidence is inconclusive but it does suggest that the utility of a training device may be at least partly a function of when the student is introduced to it.

The nature of the analyses (i.e., the factors and factor levels evaluated) were a function of which population samples provided comparable data with the necessary definitions. The statistical analyses that could be performed generally support the trends displayed in figures 20 and 21. That is, the WST performance change between the second and fifth sessions was significant for the first class ($p < 0.05$, table 9). The ASW performance change between the first and fourth ASW flights were significant for the first class ($p < 0.05$, table 11) and, while ASW 1 versus ASW 5 differences were not significant for the second class (table 10), a tendency did exist ($t = 1.18$, df - 7, $p < 0.20$).

Transfer of device training to ASW 1 was tested and found not significant (table 12). The data tend to support the transfer hypothesis but interstudent differences were too great to permit any conclusions. Again, the class factor was found to be a determiner of performance levels ($p < 0.05$).

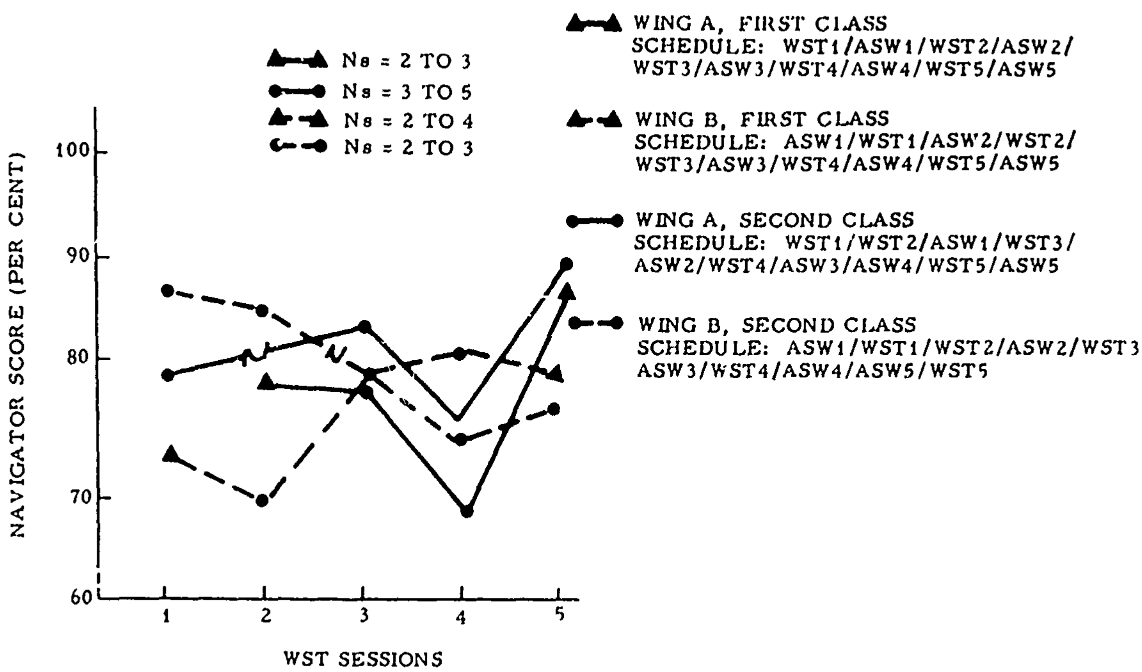


Figure 20. Navigator WST Performance as a Function of Training Schedule and Class

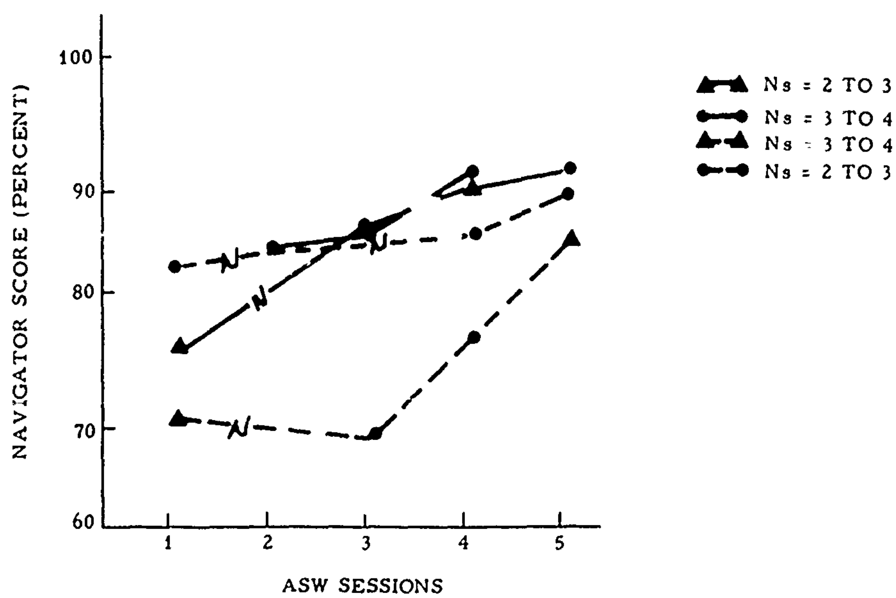


Figure 21. Navigator ASW Performance as a Function of Training Schedule and Class

TABLE 9. ANALYSIS OF VARIANCE SUMMARY FOR WST TRAINING EFFECTIVENESS FOR NAVIGATOR STUDENTS IN FIRST CLASS

Source of Variation	SS	df	MS	F
Between Students	89.8	2		
Within Students	494.8	3		
WST Sessions	454.2	1	454.2	22.37*
Residual	40.6	2	20.3	
Total	584.6	5		

*F 0.95 (1,2) = 18.5

TABLE 10. ANALYSIS OF VARIANCE SUMMARY FOR WST TRAINING EFFECTIVENESS FOR NAVIGATOR STUDENTS IN SECONDCLASS

Source of Variance	SS	df	MS	F
Between Subjects	47.7	3		
A (WST)	11.8	1	11.8	0.66
Subjects Within Group	35.9	2	18.0 m	
Within Subjects	287.7	4		
B (Wing)	43.8	1	43.8	3.56
AB	219.4	1	219.4	17.84*
B x Subjects Within Groups	24.5	2	12.3	

*F 0.90 (1,2) = 8.53

TABLE 11. ANALYSIS OF VARIANCE SUMMARY FOR ASW TRAINING EFFECTIVENESS FOR NAVIGATOR STUDENT IN FIRST CLASS

Source of Variation	SS	df	MS	F
Between Students	195.7	3		
A (Wings A, B)	131.9	1	131.9	4.13
Students Within Groups	63.8	2	31.9	
Within Students	241.8	4		
B (ASW 1, 4)	200.0	1	200.0	25.00*
AB	25.9	1	25.9	3.24
B x Students Within Group	15.9	2	8.0	

*F0.95 (1, 2) = 18.5

TABLE 12. ANALYSIS OF VARIANCE SUMMARY FOR TRANSFER OF NAVIGATOR WST TRAINING TO ASW TRAINING

Source of Variation	SS	df	MS	F
A (Wings A, B)	17.8	1	17.8	
B (Class)	458.7	1	458.7	7.36*
AB	7.8	1	7.8	
Within Cell	311.7	5	62.3	

*F 0.95 (1.5) = 6.61

JEZEBEL OPERATOR ANNOTATION ACCURACY AND COMPLETENESS. The Jezebel operator performance curves (figure 22) display a consistent learning trend up to the fourth session (most Jezebel students performed a sufficient part of each session to permit scoring; as a result it was possible to use the WST and ASW session number as an abscissa definition). The results of statistical tests of these trends were not significant for either WST or ASW training because of the small sample size (Ns = 3, 4) and interstudent differences (see tables 9 and 10). The data, however, consistently indicate performance improvement in both the WST and ASW environments with a ceiling on WST performance.*

Transfer of training from WST to ASW is supported by the available data (mean scores of 84% versus 78% based on Ns of 4 and 3), but the conclusion is again tentative because of small sample sizes. Insufficient data were obtained to permit evaluation of transfer of training from ASW to WST.

RADAR/MAD OPERATOR. Insufficient data were obtained to perform any statistical analyses of learning trends or to perform any type of transfer of training evaluation. Average performance levels as a function of WST and ASW session number are depicted in Figures 23, 24, and 25. These curves will be the basis for evaluation of learning trends.

RADAR LOG ENTRIES. Both the WST and ASW curves (figure 23) depict performance improvement with perfect terminal scores (110%) by all three students. It appears this task is well learned during the normal program of training.

MAD PROCEDURES. The curves presented in figure 24 do not display any consistent trends. Whether or not a larger sample of students would have displayed the same inconsistent pattern cannot be determined from available information. It can only be said that the mission context for MAD procedures and the poor display simulation in both training environments (training device and aircraft) may preclude effective learning to a consistent 100% level of performance within this training program.

MAD TAPE ANNOTATIONS. These performance curves (figure 25) do display relatively consistent trends toward improved performance and, based on this evidence, it appears that learning has occurred.

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*It is hypothesized that this WST ceiling effect is a function of the poor simulation of Jezebel and DIFAR signal characteristics inherent in the training device at the time when this study was conducted. Since annotation activity tends to reflect the students interpretation of signal characteristics, it is possible that training students to a 100% annotation criterion in the device would result in initial negative transfer effects in the ASW environment.

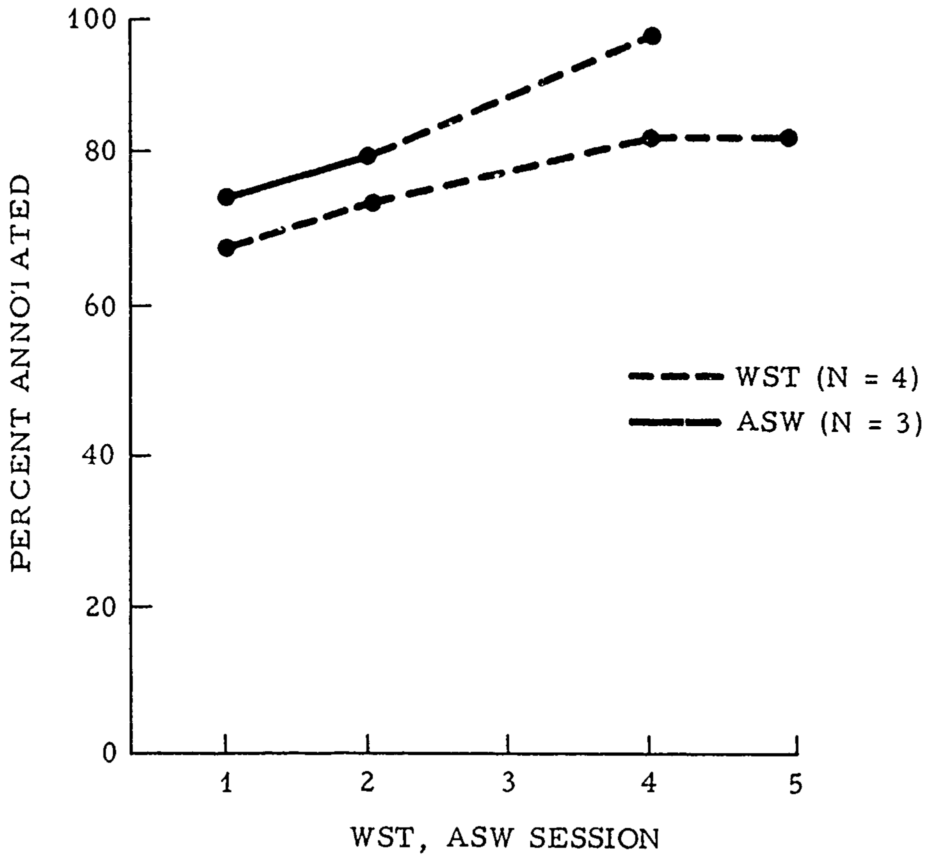

Figure 22. Individual: Jezebel Operator Annotation Accuracy and Completeness

TABLE 13. ANALYSIS OF VARIANCE SUMMARY FOR WST TRAINING EFFECTIVENESS FOR JEZEBEL OPERATOR ANNOTATION PERFORMANCE

Source of Variation	SS	df	MS	F
Between Students	507.37	3		
Within Students	1049.50	4		
WST Sessions	630.12	1	630.12	4.51*
Residual	419.38	3	139.79	
Total	1556.87	7	139.79	

*Not significant at the 0.10 level (F 0.75 (1, 3) = 2.02)

TABLE 14. ANALYSIS OF VARIANCE SUMMARY FOR ASW TRAINING EFFECTIVENESS FOR JEZEBEL OPERATOR ANNOTATION PERFORMANCE

Source of Variation	SS	df	MS	F
Between Students	416.33	2		
Within Students	685.00	3		
ASW Flights	450.66	1	450.66	3.85*
Residual	234.34	2	117.17	
Total	1101.33	5		

*Not significant at the 0.10 level (F 0.75 (1, 2) = 2.57)

RADAR/MAD OPERATOR

RADAR: PROCEDURES (ALL STUDENTS RETAINED IN PROGRAM SCORED 100% FROM BEGINNING

RADAR: LOG ANNOTATIONS, % COMPLETE

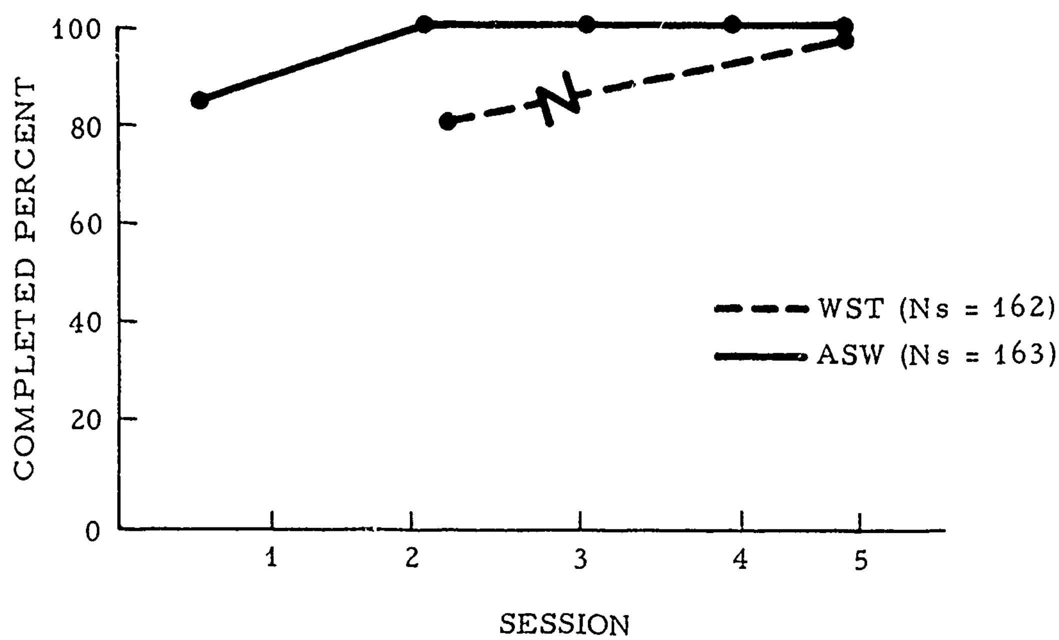

Figure 23. Individual: Radar/MAD Operator Radar Log Entries

RADAR/MAD OPERATOR

MAD: PERCENT OF PROCEDURES CORRECTLY PERFORMED AS REQUIRED

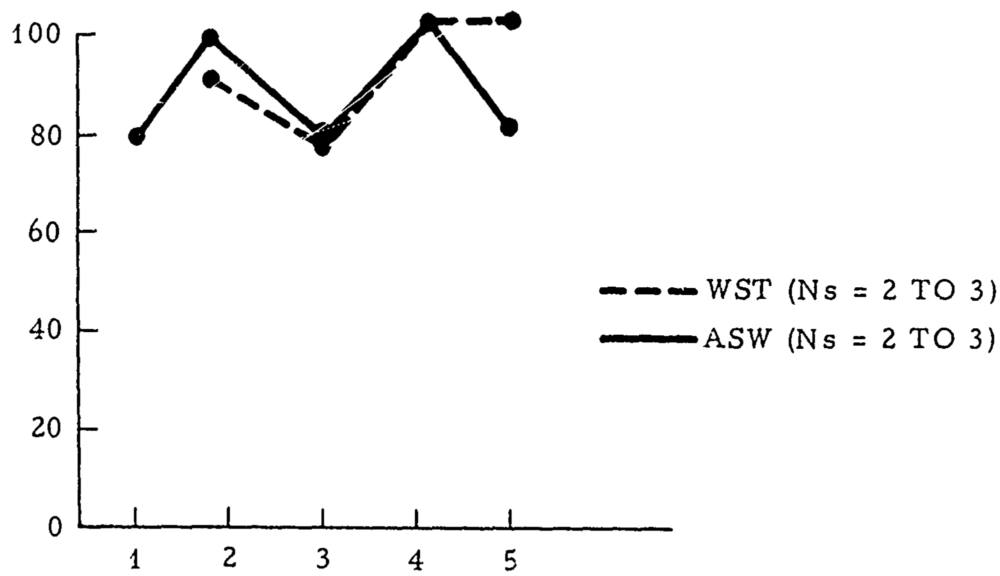

Figure 24. Individual: Radar/MAD Operator Performance of MAD Procedures

MAD: LOG ANNOTATIONS, PERCENT COMPLETE AND ACCURATE (Ns = 2 TO 3)

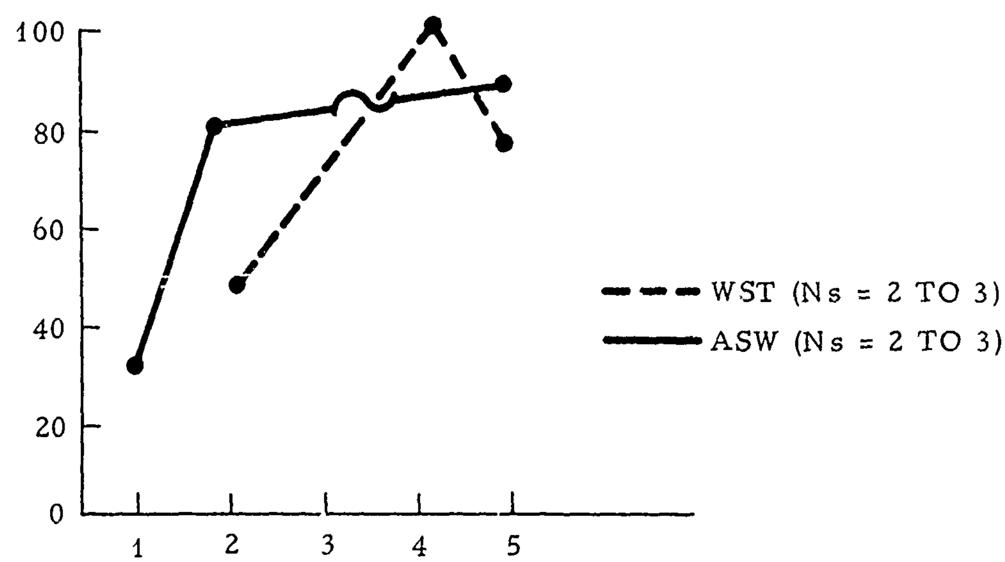

Figure 25. Individual: Radar/MAD Operator MAD Tape Annotations

SECTION IV

QUESTIONNAIRE EVALUATION OF DEVICE 2F69B

INTRODUCTION

Instructor personnel completed a questionnaire requiring ratings and comments regarding the P3A/B training device as an instructional tool for their individual positions (Appendix D). Questionnaire items relate to device characteristics and utilities in terms of task environment realism, task performance realism, and training effectiveness. Because these personnel actually use two simulations of the real world as instructional tools, the training device and aircraft, certain questions required judgments regarding both tools. Further, the judged value of inflight training missions and, therfore, the relative value of the training device, was anticipated to be a function of the targets available (surface vessels versus submarines). Therefore, questionnaire items requiring evaluations of the training device in comparison to the training aircraft suggested that the respondee provide separate ratings if he felt the type of target available altered the value of inflight training missions.

Instructor ratings of device characteristics are presented in the initial paragraphs below. These presentations are followed by discussions of instructor comments.

DEVICE CHARACTERISTICS RATINGS

DEVICE REALISM. Realism was evaluated from three standpoints (1) overall realism of the device and aircraft training environments (table 15), (2) device task environment realism as compared to the inflight situation (figure 26 and table 16), and (3) task performance realism in the device as compared to inflight task performance (figure 27 and table 17).

It can be seen from table 15 that the aircraft is considered to present the more realistic environment for the pilot, navigator, and radar/MAD operator. The trainer, on the other hand, was considered to be more realistic for the TACCO and Jezebel operator. This latter situation may be explained by the fact that ASW training flights must usually use surface vessels as targets. These vessels do not provide signals with appropriate characteristics to the Jezebel operator and will not simulate target behaviors in response to P3A/B actions. This contention is supported by tables 16 and 17, which describe evaluated device realism as compared to flights using surface vessels versus those using submarines. The device is considered comparatively realistic in the first instance, but considerably less so in the second instance.

The relatively low values given both training environments for the Jezebel operator position is apparently due not only to the low fidelity simulation of target characteristics in both cases, but also to the fact that many Jezebel students were training for assignments to DIFAR retrofit aircraft. As there

TABLE 15. AVERAGE INSTRUCTOR EVALUATIONS OF THE REALISM OF TRAINING DEVICE AND AIRCRAFT TRAINING ENVIRONMENT

Position	Training Environment Realism	
	Trainer	Aircraft
Pilot/Copilot (N = 2)	2.4*	4.4
TACCO/Navigator (N = 9)	4.0	3.2
TACCO (N = S)	4.3	3.3
Navigator (N = S)	3.3	3.9
Jezebel Operator (N = 7)	2.7	1.9
Radar/MAD Operator (N = S)	3.2	4.0

*A five point continuum was provided for each questionnaire item requiring a rating response. Scale responses were quantified using a 1.0 to 5.0 value range.

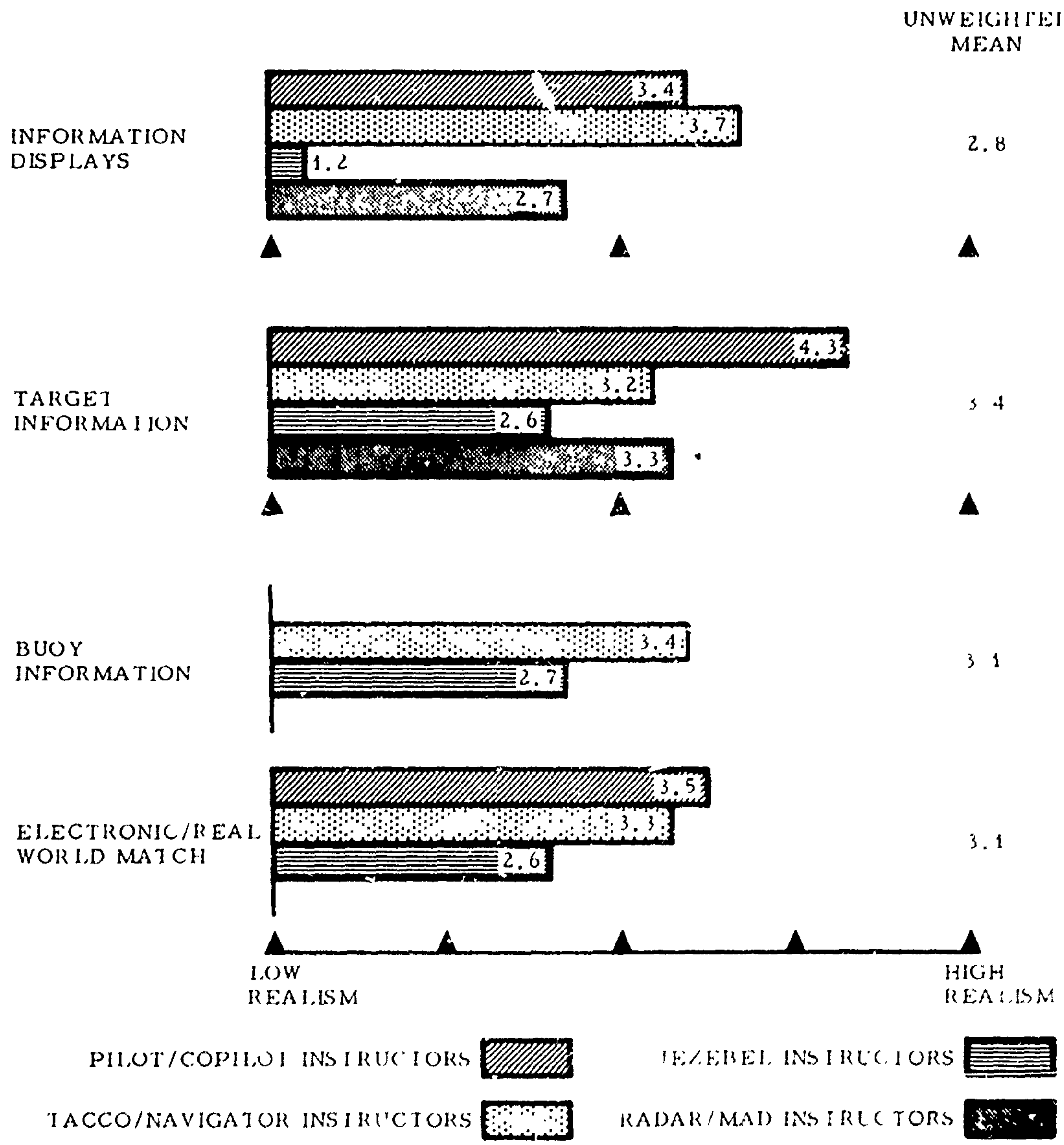

Figure 26. Trainer Evaluation: Task Environment Realism (N = 2, 9, 7, 5)

TABLE 16. COMPARISON OF TRAINER TASK ENVIRONMENT REALISMS WHEN EVALUATED AGAINST SURFACE VESSEL TRAINING FLIGHTS VERSUS SUBMARINE TRAINING FLIGHTS

Task Environment Factors/ Positions	Trainer Task Environment Realism: Compared to Surface Vessel Training Flights	Trainer Task Environment Realism: Compared to Submarine Training Flights
Target Information		
Pilot/Copilot (N = 1)	5.0	4.0
TACCO/Navigator (N = 5)	4.2	2.2
Jezebel (N = 3)	4.2 $\bar{x}$ = 4.3	1.8 $\bar{x}$ = 24
Radar/MAD (N = 2)	3.8	1.6
Buoy Information		
TACCO/Navigator (N = 4)	4.0	2.3
Jezebel (N = 2)	4.2 $\bar{x}$ = 4.1	2.0 $\bar{x}$ = 2.2
Electronic/Real World Match		
TACCO/Navigator (N = 2)	3.5	3.3
Jezebel (N = 3)	3.3 $\bar{x}$ = 3.4	2.8 $\bar{x}$ = 3.1

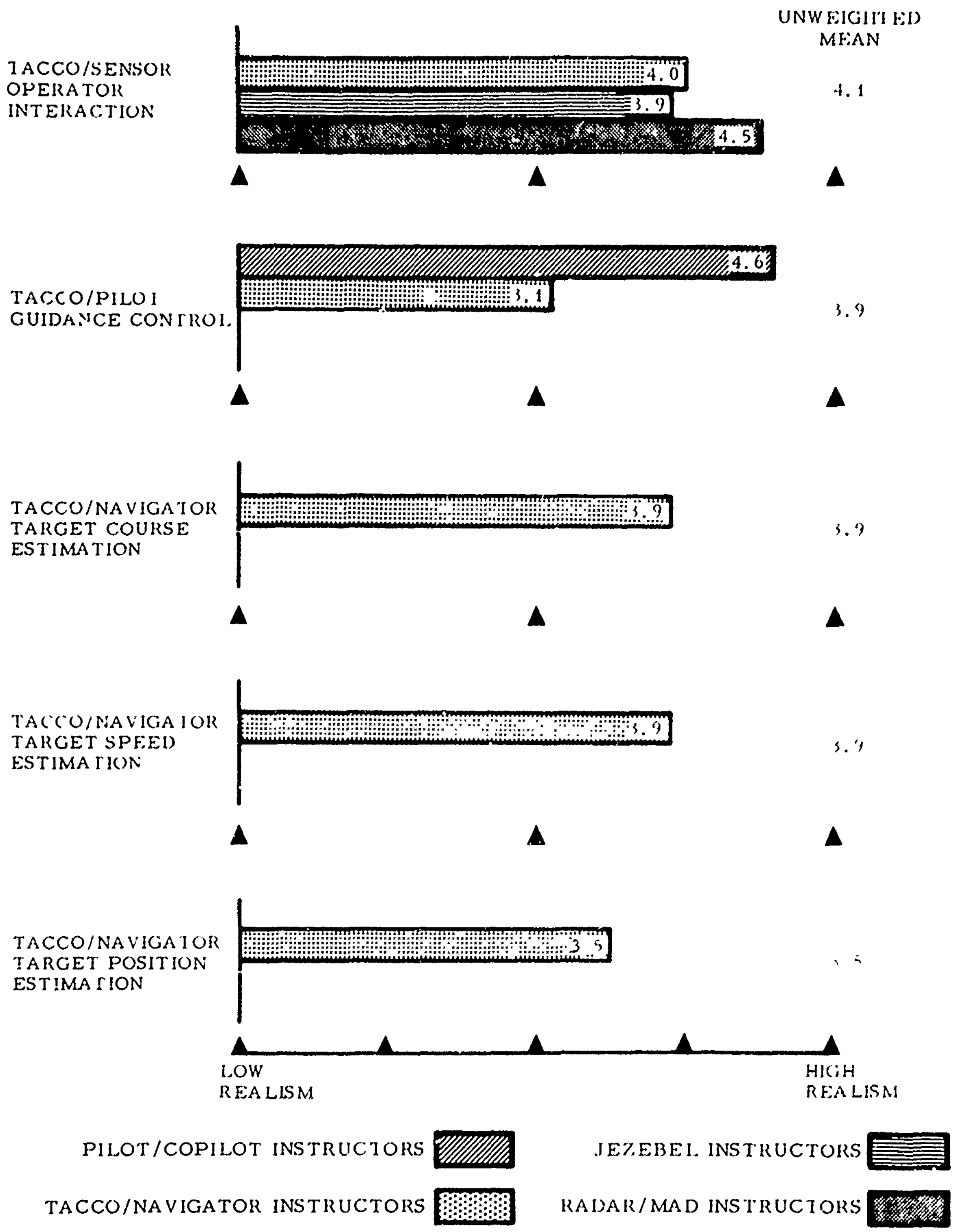

Figure 27. Trainer Evaluations: Task Performance Realism (N 2, 8, 6, 4)

TABLE 17. COMPARISON OF TASK PERFORMANCE REALISMS IN THE TRAINER WHEN EVALUATED AGAINST SURFACE VESSEL TRAINING FLIGHTS VERSUS SUBMARINE TRAINING FLIGHTS

Tasks Performed/Positions	Trainer Task Performance Realism	
	Compared to Surface Vessel Training Flights	Compared to Submarine Training Flights
TACCO/Sensor Operator Interaction		
TACCO/Navigator	4.3	2.7
Jezebel	3.9	3.2
Radar/MAD	3.8	1.6
TACCO/Pilot Guidance Control		
TACCO/Navigator	2.5	1.5
TACCO/Navigator Target Course Estimation	3.5	2.5
TACCO/Navigator Target Speed Estimation	3.5	2.5
TACCO/Navigator Target Position Estimation	3.5	2.5

are design and capability differences between the DIFAR station in retrofitted aircraft and the Jezebel station in standard P3A/B aircraft, both the trainer and the aircraft presented low fidelity simulations for these students.

Task environment realism with respect to information presentations generally tended to be rated moderately high for the pilot and TACCO positions but less so for the navigator, Jezebel, and radar/MAD positions (figure 26). The unweighted means for environmental realism characteristics range from 2.8 to 3.4. In contrast, task performance realism, in terms of crew member interactions, generally received higher ratings (figure 27). These means ranged from 3.5 to 4.1.

DEVICE EFFECTIVENESS. Effectiveness was also evaluated from three standpoints: (1) general effectiveness characteristics (figure 28 and table 18), (2) learning objectives (figure 29 and table 19), and (3) alternative learning phases (tables 20 and 21). tables 18, 19, and 21 represent the subset of TACCO/Navigator instructor personnel who provided separate responses for these two positions.

The deivce was rated as fairly effective overall and as compared to inflight training (figure 28 and table 18) for all positions except the pilot and Navigator. In contrast, the problems and problem characteristics were rated as quite effective for only the TACCO and Navigator.

The training device was rated as particularly effective for the learning objectives of knobology, procedural use of equipment, utilization of sensor information, and especially, team coordination (figure 29). It was given comparatively low ratings for effectiveness in training sensor data interpretation at the Jezebel and Radar/MAD positions, while the TACCO position received a higher rating. These poorer ratings appear to be due to low fidelity sensor data inputs to these stations.

The effectiveness of the device and the aircraft was also found to vary per position as a function of training phase (tables 20 and 21). The comparative effectiveness of the two training environments per position, across training phases, is shown by the unweighted position means in these two tables. The device is rated as best overall for TACCO students, while the inflight aircraft is rated as best overall for the pilot, navigator, and Radar/MAD students. The environments received equivalent ratings for the Jezebel operator.

Of particular interest is the comparison of the overall rated effectiveness of these two training environments per training phase (table 22). The trainer and aircraft were evaluated as roughly equivalent for the first two phases; Demonstration and Practice, and Development of Proficiency. The aircraft received a decidedly higher average rating for the Refinement of Technique phase. For Development of New Tactics, however, the trainer was evaluated as equal or better than the aircraft.

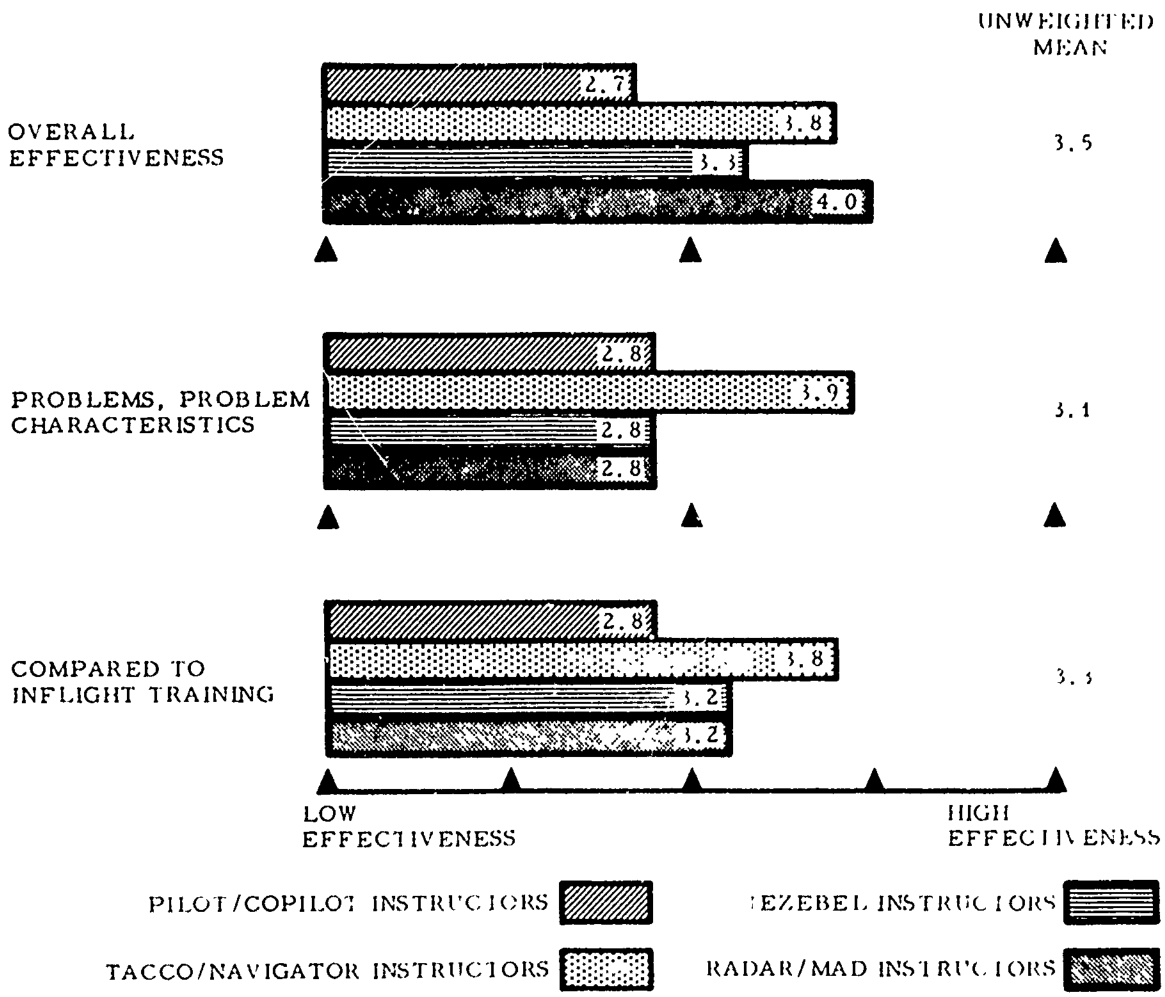

Figure 28. Trainer Evaluations: General Training Effectiveness (N = 3, 9, 7, 5)

TABLE 18. COMPARISON OF GENERAL TRAINING EFFECTIVENESS EVALUATIONS FOR THE TACCO AND NAVIGATOR POSITIONS (N = 5)

Effectiveness Characteristics	General Training Effectiveness	
	TACCO	Navigator
Overall Effectiveness	3.8	3.1
Problems, Problem Characteristics	3.8	3.7
Compared to Inflight Training	3.5	2.8

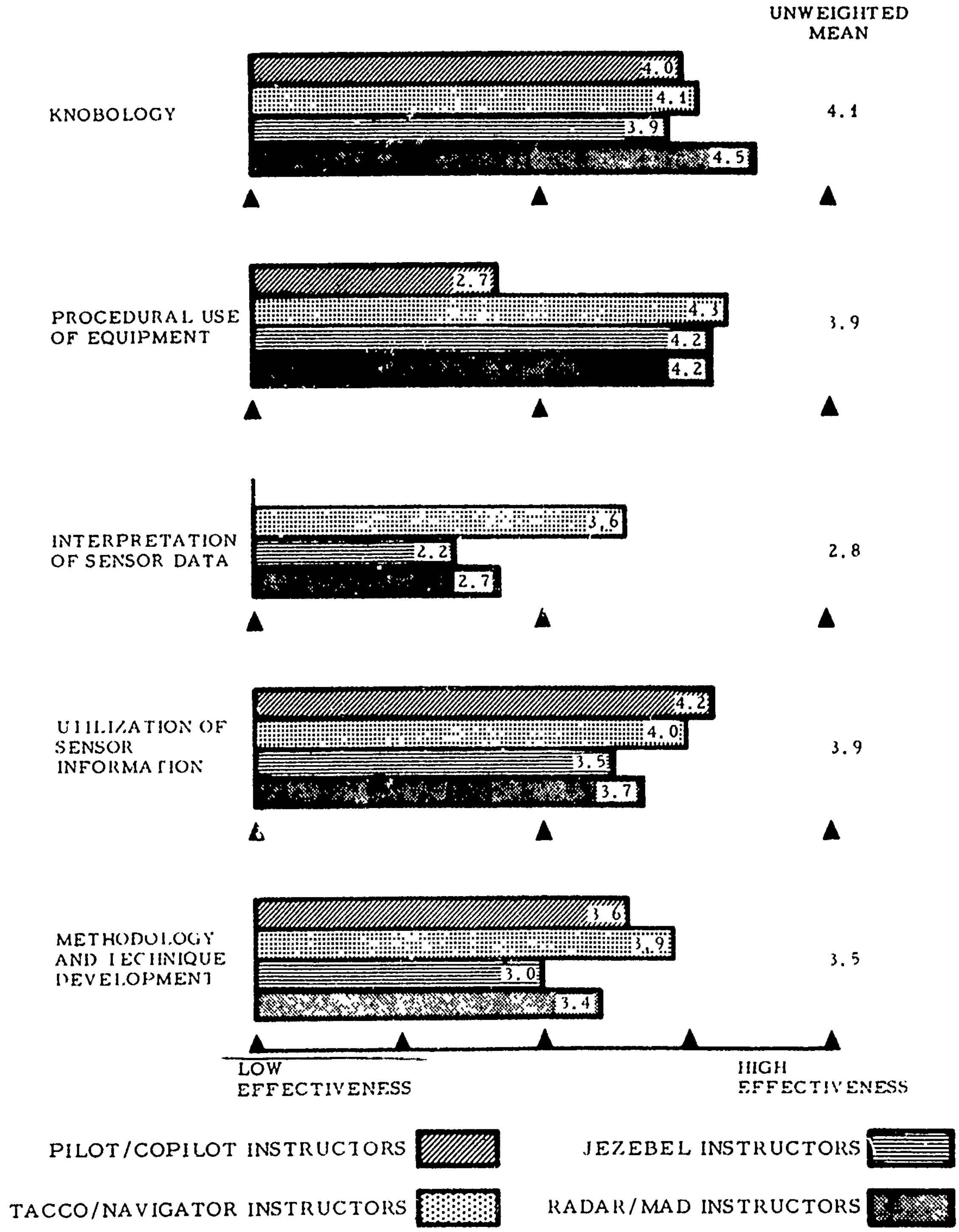

Figure 29. Trainer Evaluations: Learning Objective Training Effectiveness (N = 2, 9, 7, 5) (Part 1 of 2)

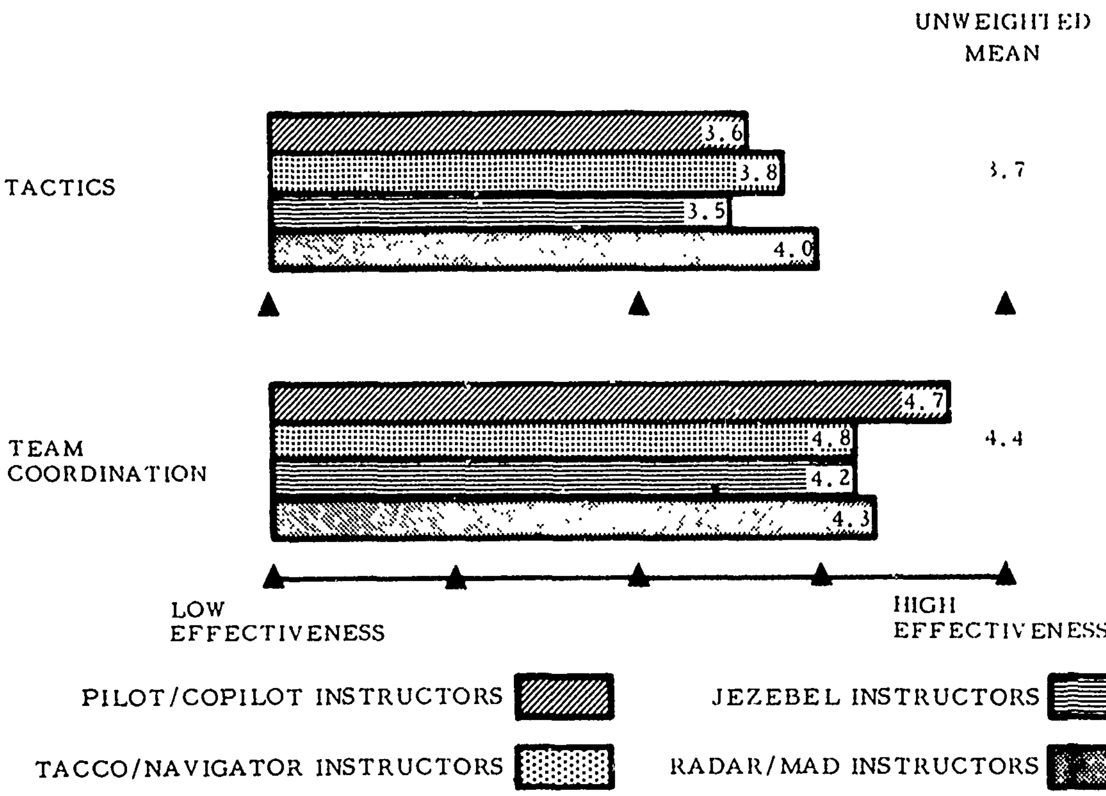

Figure 29. Trainer Evaluations: Learning Objective Training Effectiveness (N = 2, 9, 7, 5) (Part 2 of 2)

TABLE 19. COMPARISON OF LEARNING OBJECTIVE TRAINING EFFECTIVENESS EVALUATIONS FOR THE TACCO AND NAVIGATOR POSITIONS IN THE TRAINER

Learning Objectives	Training Effectiveness	
	TACCO	Navigator
Knobology (N = 4)	4.6	3.4
Procedural Use of Equipment (N = 4)	4.6	3.6
Utilization of Sensor Information (N = 2)	4.2	4.2
Methodology and Technique Development (N = 3)	3.9	3.8
Tactics (N = 2)	4.1	3.8
Team Coordination (N = 3)	4.3	4.2

TABLE 20. AVERAGE INSTRUCTOR EVALUATIONS OF THE EFFECTIVENESS OF TRAINING DEVICE AND AIRCRAFT TRAINING ENVIRONMENTS FOR ALTERNATIVE TRAINING PHASES

Position/Training Phase	Training Environment Effectiveness	
	Trainer	Aircraft
Pilot/Copilot (N = 3)		
Demonstration and Practice	2.8 Unweighted	4.2 Unweighted
Development of Proficiency	2.8 $\bar{x}$ = 3.1	4.2 $\bar{x}$ = 4.0
Refinement of Technique	3.1	3.8
Development of New Tactics	3.5	3.7
TACCO/Navigator (N = 9)		
Demonstration and Practice	4.4 Unweighted	3.3 Unweighted
Development of Proficiency	4.3 $\bar{x}$ = 4.1	3.3 $\bar{x}$ = 3.4
Refinement of Technique	3.7	3.8
Development of New Tactics	3.9	3.1
Jezebel Operator (N = 7)		
Demonstration and Practice	3.3 Unweighted	3.5 Unweighted
Development of Proficiency	3.3 $\bar{x}$ = 3.1	3.4 $\bar{x}$ = 3.2
Refinement of Technique	2.4	3.8
Development of New Tactics	3.5	1.9
Radar/MAD Operator (N = 5)		
Demonstration and Practice	3.4 Unweighted	3.9 Unweighted
Development of Proficiency	2.7 $\bar{x}$ = 3.0	3.4 $\bar{x}$ = 3.8
Refinement of Technique	2.8	4.0
Development of New Tactics	3.1	2.7

TABLE 21. COMPARISON OF TRAINING DEVICE AND AIRCRAFT TRAINING EFFECTIVENESS EVALUATION FOR THE TACCO AND NAVIGATOR POSITIONS DURING ALTERNATIVE TRAINING PHASES (N = 3)

	Training Environment Effectiveness			
	Trainer		Aircraft	
Training Phase	TACCO	Navigator	TACCO	Navigator
Demonstration and Practice	4.4	3.6	3.1	4.3
Development of Proficiency	4.4	3.2	3.0	4.1
Refinement of Technique	4.1	2.9	3.4	4.5
Development of New Tactics	4.3	3.2	3.1	3.9
Mean Evaluation	4.3	3.2	3.2	4.2

TABLE 22. OVERALL EFFECTIVENESS OF TRAINING ENVIRONMENTS PER TRAINING PHASE (UNWEIGHTED MEANS)

Training Phase	Training Environment	
	Trainer	Aircraft
Demonstration and Practice	3.5	3.7
Development of Proficiency	3.3	3.6
Refinement of Technique	3.0	3.9
Development of New Tactics	3.5	3.1*

*If Jezebel operator excluded, $\bar{x} = 3.5$

INSTRUCTOR COMMENTS

Instructor comments and suggestions to questionnaire items are presented in the following sections.

PROBLEMS AND PROBLEM CHARACTERISTICS. Questionnaire item 2 queried, "Would you change the problem characteristics in any way for training purposes? If so, what changes would you make?" Instructor responses are presented by position.

a. Pilot/Copilot. Given the limited cockpit simulation in the WST trainer and the inability to run the WST and OFT trainers in a coupled mode (the OFT trainer is unavailable due to its use as a cockpit trainer), no changes were recommended for this position.

b. TACCO/Navigator. Two problem areas were pointed to which both related to the TACCO position and impacted on other positions. The device permits instructors to vary several important environmental parameters. The effective utilization of these capabilities are limited, however, by two factors: (1) the several members of any one student team will receive assignments to diffeient fleet squadrons, which operate under differing environmental conditions and constraints; and (2) instructor personnel do not presently receive formal training in device capabilities, operating characteristics and utilization for training purposes. These problem areas could probably be resolved by modification of fleet assignment procedures, student flow patterns, and development of a training course for instructor personnel in device utilization.

c. Jezebel Operator. Suggestions made for this position point to two problemareas: (1) again, inadequate instructor training with respect to device capabilities and utilization, and (2) device limitations. It was suggested that a greater variety of targets be made available, thus providing the differing signal characteristics required for operator training, that hyperbolic LOFAR fix (HLF) capabilities be improved, and that comparative LOFAR listening (CPA) capabilities be provided.

d. Radar/MAD Operator. The present training syllabus tends to be mission, rather than crew oriented. As a result, the Radar/MAD student received irregular MAD training and very little radar training. It was strongly recommended that the student receive more radar training, both in the device and in flight.

DEVICE TRAINING EFFECTIVENESS. The first question posed under item 3 was: "Are there any aspects of the ASW mission (e.g., coordination, target information, etc.) for which the trainer provides better training than the inflight training missions do? If so, please discuss them." Instructors answered the question asked and/or indicated why the trainer was a better instructional tool. The instructors were unanimous, across position, in describing the whys: (1) the ability to "freeze" the problem during the WST mission so that errors can be discussed, proper procedures demonstrated, or alternative courses of action discussed; (2) the ability to have a submerged target and, further, to control both target and merchant vessels such that the tactical mission evolves realistically and situations can be presented for instructional purposes; and (3) economies resulting from no fuel costs, no need to abort missions due to downed equipments, and no time spent in preflight and transit to an operations area. Other responses are presented per position.

a. Pilot/Copilot. The device was described as "excellent" for crew coordination training. One instructor also commented that the trainer was very good for beginning ASW pilots, while either the trainer or the aircraft was acceptable for experienced ASW pilots.

b. TACCO/Navigator. The device is viewed as being most effective in teaching crew coordination, knoboloby, procedures, and localization tactics.

c. Jezebel Operator. All responses provided further emphasis for (1) and (2) above.

d. Radar/MAD Operator. The five responses to this question expressed divergent opinions. Two instructors indicated device training was not a better instructional tool for any aspect of the operational ASW mission. One respondee agreed, but excepted crew coordination training. The other two respondees indicated the trainer was more realistic for radar operations in terms of target behavior and indicated that item (1) above was an advantage.

AIRCRAFT TRAINING EFFECTIVENESS. The second question posed under questionnaire item 3 was: "Are there any aspects of the operational ASW mission for which the inflight training missions provide better training than the trainer does? If so, please discuss them." The instructors rather unanimously pointed to those environmental factors which are not simulated in the device. The ASW crew must operate within the environmental constraints imposed by the aircraft (e.g., noise, vibration, g-forces, etc.), the airspace (e.g., wind and pressure variations), and the sea (e.g., temperature levels, sea state). The aircraft is thus seen as training the students to operate within environmental constraints and to appropriately respond to environmental parameters.

a. Pilot and Navigator. External visual references (e.g., buoys, smoke bombs) and LORAN an be used in the aircraft but not in the simulator. Thus, the aircraft provides training to these positions which cannot presently be obtained in the trainer.

b. TACCO. No additional comments.

c. Jezebel Operator. CPA patterns are not presented and thus CPA activities can be trained only in the aircraft.

d. Radar/MAD Operator. Both the radar and MAD displays are more realistic in the aircraft, thus providing better training in sensor data interpretation. It was pointed out, however, that the present inflight training syllabus provides little opportunity for the radar operator to perform and, therefore, to learn his tasks (the same is true, incidently, of the WST syllabus).

DISPLAYS. Question 4 required a rating in response to, "How realistic are the displays of sensor data and/or other information at this position in the trainer?", and then asked, "What improvements would you suggest, where?".

a. Pilot/Copilot. Display realism for this station was generally described as "excellent." The only exceptions made related to the OTPI in that the one in the trainer is far more accurate than the ones in aircraft.

b. TACCO/Navigator. The displays for these positions were described as ". . . probably more realistic than any other in the trainer" and most of the recommendations given related to the sensor stations. Recommendations for the TACCO/Navigator positions included updating the torpedo panels to include MK-46s and the additions of a LORAN simulation and the ASA-47 D/AM computer to the Navigator station.

c. Jezebel Operator. Several instructors made the following recommendations: (1) develop new high fidelity target sound tracks so that aural listening tasks can be learned in the trainer, (2) develop new high-fidelity Jezebel tapes so that the student can be exposed to a wider selection of submarine types and gram interpretation skills can be trained, (3) improve trainer capability to realistically simulate signal characteristics associated with HLF and CLF functions, and (4) introduce a realistic simulation of CPA. The low-fidelity signal characteristic simulations for a limited inventory of out-of-date targets limits the amount of training these instructors can provide to their Jezebel students. A final recommendation was that the trainer's AQA-5 be replaced with the AQA-7.

d. Radar/MAD Operator. Both the radar and MAD displays were described as presenting very unrealistic signal characteristics, thus limiting the amount of training that can be provided. It was recommended that both displays be made more realistic overall (e.g., display sea states on the radar, improve MAD response behaviors) and display signals with higher fidelity.

DEVICE DESIGN. Question 8 queried, "In terms of working with the trainee during a training session, which aspects of the trainer's design do you feel aid or hinder your efforts as an instructor?" Many responses were similar to ones already made to other questions (e.g., ability to "freeze" the problem, unrealistic signal characteristics). Several instructors pointed, however, to the ability to observe the students, obtain problem parameter readouts in the instructor station, observe the optical mission plotter, and to control many problem parameters as being very desirable design features. The compactness of the design, causing instructor personnel crowding, was pointed to as a negative design feature. Position-specific comments follow:

a. Pilot/Copilot. The WST has been designed to permit ordnance system training (weapons employment, jettison demonstrations). Favorable comments were made regarding this design feature.

b. TACCO/Navigator. Favorable comments were made regarding the extent to which activities could be monitored, but suggestions were made to further improve this capability. It was suggested that the area directly behind these positions might be elevated or otherwise altered so as to permit better observation of the DRT without interference. It was also suggested that the ability to monitor non-ICS communications from the instructor's station would permit better evaluation of crew interactions, especially between the TACCO and Navigator.

c. Jezebel Operator. No comments were made over and above those discussed above.

d. Radar/MAD Operator. The limitation in number of radar targets was described as a poor design feature. All other comments have been discussed elsewhere.

STUDENT PERFORMANCE EVALUATION. Question 9 asked, "Are there any modifications or improvements you would suggest that would allow better or more efficient evaluation of student performance at this station (i.e., either in the form of recording devices, better or more slave equipment, etc.)?"

a. Pilot/Copilot. It was recommended that, if the WST and OFT trainers cannot be used in a coupled mode, that the pilot station be separated from the instructor's station and optical mission plotter. Although the possession of special "inside" knowledge by student pilots regarding mission progression did not often appear to affect team behaviors and performances, there were instances of either positive effects (e.g., TACCO prompting by the pilot) and negative effects (e.g., pilot responses when he knew the TACCO's commands were inappropriate). This feature of simulator design should be eliminated from future models of this equipment.

b. TACCO/Navigator. Grading criteria and number of students per position per crew were presented as problem areas. The training squadron continually works on upgrading scoring criteria and developed some new insights as a result of this study. The number of students in an ASW class has been a continuing problem and class overloads detract from the instructor's ability to provide adequate training and performance evaluation.

It was also suggested that these positions might benefit from printouts of the mission plot for later analysis.

c. Jezebel Operator. All responses to this question have been discussed elsewhere.

d. Radar/MAD Operator. No changes were recommended.

DEVICE MAINTENANCE. Question 10 queried, "Are there any changes in maintenance you would suggest?" Three comments were made in response to this question by instructors at all positions: (1) Give the trainer a higher priority and a larger maintenance budget such that replacement parts will be made quickly available when needed; (2) Provide a second trainer so that adequate maintenance downtime can be increased. At present, the trainer is utilized by both training and fleet squadrons. As a result, the downtime for maintenance has been reduced to an unacceptable minimum; and (3) The maintenance personnel were given high marks for making the best of a difficult situation. It was also recommended that additional qualified personnel be added to the maintenance staff.

TRAINING SCHEDULES. Question 11 asked, "Would you change the amount of training time presently spent in the trainer or in the aircraft, or would you suggest any different utilization of the two training environments (e.g., scheduling)? If so, please discuss the changes you would make and explain the expected advantages."

The consensus of opinion appears to be that: (1) the number of ASW flights could be decreased by at least one; (2) the number of WST sessions could be increased for the TACCO, Navigator, and Jezebel positions; and (3) the number of both WST and ASW training missions could be reduced for the Radar/MAD position. Specific comments are presented below.

a. Pilot/Copilot. Three instructors recommended an additional WST session prior to the first ASW flight for both the pilot and TACCO students. Only one instructor recommended no changes. In addition, it was suggested that these students would benefit by gaining some experience in performing the tasks associated with the sensor operator positions. It was also suggested that all students should be allowed to observe instructors running through some sample problems for one WST session, both for instructional purposes and to provide the students with insight into desirable performance standards.

b. TACCO/Navigator. Five out of six instructors indicated that the number of WST sessions should be increased and the number of ASW sessions decreased, especially for the TACCO position. The sixth instructor did not feel the questionnaire was a proper vehicle for discussion of this issue. The instructors recommended that the number of WSTs be increased to seven or eight and that the number of ASWs be reduced to four or five (given that a submarine is normally not available for ASW training missions).

c. Jezebel Operator. One instructor responded, "It is a fine schedule" and another suggested "Increase aircraft time with a real world submarine." The other 4 Jezebel instructors all recommended an increase in trainer sessions and a decrease in flights (one even suggested nine WST sessions and only three ASW missions). Localization procedures were indicated as one area which would particularly benefit from additional WST training.

d. Radar/MAD Operator. The consensus of opinion was that these students derive little benefit from the present training program because of the nature of the WST and ASW syllabi and the low fidelity simulations of target characteristics. If the present training program and simulation fidelities are maintained, it was recommended that the participation of these students be reduced or eliminated.

OTHER RECOMMENDATIONS. All comments made by instructor personnel to the final questionnaire item fell into one of the above categories with one exception: comments regarding the 14B35 device. This is a 120-pound device which must be installed in the aircraft prior to each flight and removed at flight conclusion. It is used by instructor personnel to control target information presented to the students and is necessitated by the use of merchant vessels which do not provide submarine signal characteristics. It was recommended that the device be permanently installed (considerable effort is required to remove and replace the device) and that it be redesigned or modified to present higher fidelity signals to the students.

TRAINING DEVICE COMPARISONS. Training effectiveness and device realism questionnaires have now been administered to the instructor personnel for three team training devices: S2E (an ASW aircraft WST), Carrier Air Traffic Control Center (CATCC), and P3A/B. Although several of the questions in each questionnaire were unique to the individual device and associated training program, there were some commonalities with respect to either the collective intent of certain questions or the questions per se. Instructor responses per device are presented in tables 23 and 24 for those interests and questions where comparisons appeared to be meaningful. It is suggested that the differences in trainer effectiveness values is a function of the match between simulation fidelity for team positions, individually and collectively, and the training objectives selected and/or quiet precedence. Information displays and other inputs to a position have several characteristics, subsets of which are relevant to individual training objectives. It is suggested that the P3A/B

TABLE 23. COMPARISON OF THE P3A/B AND CATCC TRAINER WITH RESPECT TO AVERAGED TASK ENVIRONMENT REALISM, TASK PERFORMANCE REALISM, AND TRAINING EFFECTIVENESS CHARACTERISTICS EVALUATIONS

	Task Environment Realism	Task Performance Realism	Training Effectiveness
P3A/B	3.1	3.9	3.6
CATCC	4.0	3.9	4.4

TABLE 24. COMPARISON OF THE S2E, P3A/B AND CATCC TEAM TRAINER EVALUATIONS WITH RESPECT TO SPECIFIC REALISM AND EFFECTIVENESS QUESTIONS

Questions	Trainers		
	S2E	P3A/B	CATCC
Realism:			
Information Displays	3.7	2.8	4.7
Training Effectiveness:			
Overall	3.5	3.1	4.6
Compared to OJT (Inflight, On-board Ship)	3.6	3.3	4.3
Team Coordination	3.9	4.4	4.5

trainer very adequately simulates those characteristics of information inputs to the TACCO position, relevant to TACCO training objectives, and to all positions in terms of the team coordination training objectives. It did not as adequately simulate inputs to the other positions in terms of their individual training requirements (e.g., interpretation skills). Undoubtedly trainer effectiveness depends largely on the extent to which trainer design implements clearly defined training requirements.

SECTION V

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

TACTICS TRAINING OCCURS PREDOMINANTLY IN THE WST. It was apparent from the study data, questionnaire responses, and direct observation of training activities that the most beneficial ASW tactics training occurs in the WST. The ASW students seldom encounter an actual submarine during their airborne training sessions. Therefore, the simulator is usually the only means of introducing prospective ASW crews to the characteristics of submarines operating in a submerged environment. The major drawback to the WST is that it does not provide a high-fidelity representation of nuclear submarine operating characteristics. Nuclear submarines are simulated by causing diesel submarine targets to operate at higher speeds. Nuclear submarine training tapes are available, but the WST instructors do not consider them to be useful in the training situation because most of the operating characteristics of the simulated submarine cannot be varied.

TRAINING OCCURS AND POSITIVE TRANSFER IS EVIDENT. Although the number of subjects was small in most of the data analyses, the general trend clearly indicated that learning takes place in the simulator and that there is positive transfer to the airborne environment. It was also evident that the TACCO receives the major benefit from the WST training sessions. The navigator benefits to a lesser extent, as does the Julie operator. The radar/MAD operator gains little or no benefit. The worst training conditions exist for the Jezebel operator. In the case of the Jezebel operator, it is possible for the operator to experience negative transfer as he transitions from the WST to the airborne environment as a function of equipment differences and lack of JEZ program fidelity.

POSSIBILITY OF NEGATIVE TRANSFER OF THE JEZEBEL OPERATOR'S POSITION. The possibility for negative transfer to occur at the Jezebel operator's position existed because different Jezebel equipment appeared in the simulator than in the aircraft. The simulator incorporated the AQA-5 version of the equipment. An operator transitioning to an AQA-7 equipped aircraft was confronted by entirely new equipment which was considerably more sophisticated than the equipment encountered in the simulator. If he was not scheduled to transition to an AQA-7 equipped aircraft, he often received his airborne training in an aircraft equipped with an AQA-4 system. This latter equipment was considerably less sophisticated than the AQA-5. Recent personal communication with training squadron instructors indicates that many of these problems will be eliminated when the DIFAR retrofit equipment are incorporated into the aircraft and the simulator.

LACK OF TRAINING FOR THE ORDNANCE MAN. The ordnance man is generally excluded from the WST sessions because of crowded conditions in the trainers. Inappropriate responses by the ordnance student can completely disorganize a training problem. Consequently, in order to reduce confusion in the trainer, he is usually invited to attend only a single WST training session.

OVERCROWDED CLASS CONDITIONS. A serious training problem exists because the student population is too high for each class. Team training devices are generally utilized according to a syllabus and time schedule designed to train one complete team. The availability of training devices and aircraft and the flexibility of the ASW training schedules is limited. The availability of instructor personnel is limited by the specialized technical background and skill requirements for those positions. In short, the P3A/B training program cannot easily accommodate any deviations from one complete crew per instructor, and one crew member per crew position.

RECOMMENDATIONS

STUDENT FLOW MANAGEMENT. It is strongly recommended that the agencies responsible for managing student flows which ultimately merge into a crew training program carefully review management policies and flow operations to determine how the student input requirements for these programs can be rendered more realistic. It is also recommended that consideration be given to ways of easing the training equipment and schedule constraints within which training cadres must operate. Certainly the provision of additional training equipment, support systems (e.g., software capabilities), and personnel would create a training environment better able to accommodate complex ASW training requirements. The degradation of training completeness and effectiveness resulting from student overloads could lead to undertrained personnel and potentially serious operational consequences.

TEAM COORDINATION TRAINING. It is recommended that greater emphasis be devoted to team coordination training. It is recommended that the syllabus be revised to emphasize scenarios requiring interaction between team members. Student evaluation could also be based on interaction criteria. For example, performance could be assessed on the basis of such parameters of crew interaction as timeliness of response, provision of information critical to problem solution, method of presenting critical information to the crew members, obtaining and managing information sources, etc.

TRAINING OF SENSOR OPERATORS. The sensor operators have essentially three functions: interpreting the incoming data, entering both sensor and mission information into logs and onto the sensor tapes so that it can be analyzed after mission completion, and providing data interpretations in the form required to expedite accomplishment of mission objectives. The trainer is considered effective for training the latter function. It is not considered effective for training the first function, sensor data interpretation. Sensor data interpretation is, in all cases, based primarily on physical characteristics of the signal which vary as a function of target parameter values. The student sensor operator cannot learn to correctly interpret sensor data unless he has a high-fidelity representation of the manner in which these signal characteristics vary. It is unlikely that the presence of other team members will have much direct bearing on his acquisition of interpretation skills.

The P3A/B trainer does not presently provide high-fidelity signals to the sensor positions, primarily as a result of maintenance and design limitations.

If the P3 DIFAR retrofit trainers do provide such signals, it is recommended that signal interpretation training be given in the device to the sensor operator positions individually (e.g., one or two sessions for only the Jezebel students, etc.) with the instructors for each position attempting to make maximum use of the device for training that function (e.g., demonstration, presentation of problems, etc.). Thereafter, additional training should occur within the team training context.

MODIFICATION OF TACCO TRAINING. The TACCO does not deal with signal characteristics directly, instead he relies on interpretations supplied by novice sensor operators. Thus, the student TACCO must always operate under the assumption that an error probability is associated with sensor data interpretation. For this reason, it is recommended that the TACCO students receive two or three extra sessions wherein the sensor operator positions are filled by instructor personnel. Application of this procedure would clearly facilitate refinement of student TACCO operating techniques.

ORDNANCE TRAINING. The ordnance man can, and often does, degrade actual ASW operations. The ordnance man interacts with the TACCO and to a small degree with the pilot. In order to assure that ordnance man performance degradations are reduced, it is recommended that this student be provided with additional WST training during team training operations.

INSTRUCTOR TRAINING. At the present time, WST instructors do not receive formal instruction in training device capabilities with respect to control of problem variables or how to utilize these to implement training objectives. The extent to which an instructor is aware of device capabilities and uses is presently a function of relatively informal on-the-job training and his own curiosity and persistence. It is recommended that a training course in device utilization be formally structured and administered with periodic demonstrations by the instructor that device operating and instructing proficiency has been maintained.

INCREASE TOTAL NUMBER OF WST SESSIONS. The training device presents a quieter training environment facilitating student-instructor interaction. It also provides a problem "freeze" capability and a real-time mission plot which enables the instructor to provide the student with immediate feedback regarding the adequacy of his performance. Because the WST presents a higher fidelity situation to the TACCO and most of the other members of the crew than does the training aircraft, it is recommended that the number of WST sessions be increased by at least one. It is also recommended that the number of airborne training sessions be reduced by at least one. Reduction of the total number of training flights accompanied by an increase in the total number of WST sessions should result in improved ASW tactics training at less cost to the Navy.

DESIGN OF FUTURE EXPERIMENTS. The current series of experiments were on the threshold of completing a true transfer of training study. It is recommended that in future similar investigations a training squadron be sought that will "bite the bullet" and allow one group of students to complete a full course of instruction without access to the WST. The airborne ASW performance of these crews could then be compared with a like group having been trained in both the simulator and aircraft. This situation was established for only the first WST session of the current study. Although the data from these sessions were promising, greater confidence could be placed in the obtained results if better control had been obtained over the experimental environment.

In addition to the WST/non-WST condition, it would be extremely useful to test airborne ASW performance against actual submarine targets. This would allow a full test of the transfer of training parameter as it relates to the "ultimate" performance criterion.

APPENDIX A

REPORT ON 2C23 SIMULATOR EVALUATION

EVALUATION OF 2C23 SIMULATOR

The 2C23 simulator, located in Bldg. 453 at the Patuxent River Naval Air Station, is a cockpit procedures trainer for the P-3 aircraft. It is used to familiarize beginning students with the location of the various switches in the cockpit and the procedures involved in normal aircraft operations.

The trainer consists of simulated cockpit panels affixed to a platform (approximately 10 feet by 10 feet). A railing that is approximately 3-1/2 feet high extends around the perimeter of the platform. An instructor's panel containing a series of switches that control system operating and warning lights located on the student's cockpit panels is attached to the railing. The instructor panel can be operated from either inside the platform or from outside. If the instructor stands inside the platform he is required to look away from the cockpit to manipulate his control panel switches. If the instructor stands outside the platform, he can look directly into the cockpit while operating his control panel.

None of the lights in the cockpit can be activated by the student as he manipulates the cockpit panel switches. The student's panel lights can only be illuminated from the instructor's control panel.

SIMULATOR UTILIZATION PROBLEMS

Interviews with several 2C23 instructors produced the following complaints related to use of the simulator in the instructional process.

1. INSTRUCTOR PANEL LOCATION. Because the student's cockpit lights can only be operated from the instructor's panel, a significant portion of the instructor's time is devoted to watching the student manipulate cockpit switches. In order to keep the student's switch manipulation constantly in view, the instructor is required to operate his simulator control panel from outside the platform. The instructors do not like this feature of the simulator. From an instructional point of view, they prefer to stand inside the platform where student performance can be more easily monitored and where complex procedures can be demonstrated in detail. Whenever possible, two instructors are used on the trainer; one to operate the instructor panel, the other to provide detailed explanations of complex procedures.

2. SEQUENCE OF SWITCH MANIPULATION. Several aircraft operating procedures involve momentary panel light illumination to indicate correct completion of a procedural step. When a rapid sequencing of switches and lights is involved, an instructor must be highly current on simulator operations to effect a realistic sequencing of systems performance indicators. The instructors point out that it is fairly difficult to maintain the desired level of control panel proficiency. This inability to remain current on the operation of the instructor's panel is largely a function of the time lapse between classes.

3. INSTRUCTOR PANEL SWITCHES

a. The fuel filter indicator light and the low-pressure indicator (the latter indicates centrifugal fuel boost pump failure) are controlled by the same switch. The instructors prefer a single switch for each.

b. The hydraulic oil pressure switch is mislabeled.

4. COCKPIT PANEL SWITCHES

a. The RPM switches (4) and oil cooler switches (4) have a different configuration than those on the aircraft. The switches on the simulator are small, chrome-covered paddle switches. On the aircraft, they are large, grey, plastic paddle switches.

b. The oil cooler switches should be spring-loaded from "closed" to "neutral" or "off" on the trainer. In the present mockup, they do not operate this way.

c. On the overhead panel, the lights test switch for the APU should be a pushbutton switch.

d. In the simulator, the APU inflight arming switch is upside down in relation to the way it is positioned in the aircraft. Since it is also depicted upside down in the NATOPS manual, the instructors have been unable to effect a change in the switch configuration included in the simulator.

RECOMMENDATIONS FOR IMPROVING TRAINER UTILITY

One feature, developing functional cockpit switches, was deemed most likely to enhance trainer utility. Other desirable features alluded to during these conversations can be lumped under the heading of features that would be "nice to have." These other features consisting mostly of additional switching and circuit breaker capabilities appear below:

a. If the cockpit switches could be made functional, the instructors would like to be able to activate panel lights from either the instructor or cockpit panels or both. This would require the introduction of a remote/local switch on the instructor's control panel.

b. A few procedures such as engine restart, shutdown, etc., involve activating several switches on the instructor panel. These switches should be activated simultaneously. At present, they can only be activated in sequence. To overcome this drawback, the instructors would like to have a single master switch installed for these procedures on the instructor panel. This would enable a single switch to perform the same function currently performed by a combination of switches.

c. A few procedures involve activating several switches on the instructor panel in rapid sequence. This creates problems because the switches are not grouped together. The instructors indicated that relocation of the switches was not feasible. However, they were inclined to think color coding various switch combinations for critical procedures might aid in reducing "search" time.

d. The instructors indicated that inclusion of the flight essential AC and DC circuit breakers on the forward load center (panel to the rear of the copilot station) would have a beneficial influence on instruction.

e. Actual "test" switches to turn on all lights on a particular panel were thought to be desirable.

f. The following additional controls were also indicated as desirable:

1. Ground or external power switch
2. Boost handles on the bottom of the center control stand
3. Cabin pressure control on the overhead panel
4. Pushbuttons (4) for pressure circuit override to replace drawings of these switches
5. Regulation start selector and starter button.

GENERAL COMMENT

The bulk of the interview data on the 2C23 trainer was obtained from two instructors. Other instructional staff members from VP-30 offered some general comments. However, most of these centered on making the cockpit switches functional. From the viewpoint of the two Bunker Ramo observers, the 2C23 trainer appears to be effective in the role for which it was designed. It is apparent from the interviews that the instructional staff desire a number of modifications to the current model of the simulator. It is recommended that modifications which are not expensive be accomplished. If a modification requires significant simulator redesign or expenditure of funds, it can be classed as unnecessary. Although the simulator, in its current configuration, presents the instructor with some complex task requirements, they do not exceed his manipulatory capabilities.

APPENDIX B

DATA COLLECTION CHECKLISTS

DATA COLLECTION COORDINATOR (DCC)

General Instructions

The DCC will be responsible for the overall data collection effort among himself, the simulator operator, and enlisted instructor, during each Weapons System Trainer (WST) session, in accordance with the Master Schedule contained on page 81.

In addition to coordinating data collection, the DCC will complete the attached checklist, or portions thereof, during each WST session. Checklist entries will include time and Pilot Bearing Distance Heading Indicator readings at specified points during the WST mission.

Finally, the DCC will be responsible for collecting, arranging and scoring the following data items at the end of each WST session.

(1) Navigator Log

(2) Navigator Dead Reckoning Trace (DRT)

(3) Jezebel Operator's Log

(4) AQA-5 Recorder Synchronization Chart

(5) Julie/ECM Operator's Log

(6) ASA-20 Recorder Tape

(7) Radar Operator's Log

(8) RO-32 Magnetic Distortion Recorder Tape

(9) Graphic Presentation Overlay Trace

(10) Completed Simulator Operator Checklist

(11) Completed Enlisted Instructor Checklist

(12) Completed Data Collection Coordinator Checklist.

MASTER SCHEDULE

WST Session	Event	Data Collector	Output
1 through 5	Problem Insert	Simulator Operator	Checklist
1 through 5	Nav Stab		
	Crew	Simulator Operator	Checklist
	PPC	DCC	Checklist
	TACCO	Enlisted Instructor	Checklist
	Nav	Enlisted Instructor	Checklist
1, 4, and 5	Search		
1, 4, and 5	LOFAR		
	Crew	Simulator Operator	Checklist
	Jezebel Operator	Simulator	AQA-5 Tape
	PPC	DCC	Checklist
	TACCO	Enlisted Instructor	Checklist
	Nav	Enlisted Instructor	Checklist
	Julie	Simulator	Log/Graphic Presentation
	Radar		
	Crew	Simulator Operator	
	Radar		
	Operator	Simulator	Log/Graphic Presentation
	TACCO	Enlisted Instructor	Checklist
	Nav	Enlisted Instructor	Checklist
	PPC	DCC	Checklist
	ECM Triangulation		
	Crew	Simulator Operator	Checklist
	ECM		
	Operator	Simulator	Log/Graphic Presentations
	TACCO	Enlisted Instructor	Checklist
	Nav	Enlisted Instructor	Checklist
	PPC	DCC	Checklist
2, 4, and 5	CODAR		
	Crew	Simulator Operator	Checklist
	Jezebel		
	Operator	Simulator	AQA-5 Tape
	TACCO	Enlisted Instructor	Checklist
	Nav	Enlisted Instructor	Checklist
	Julie	Simulator	Log/Graphic Presentation
	PPC	DCC	Checklist

MASTER SCHEDULE (continued)

WST Session	Event	Data Collector	Output
2, 3, and 5	Julie		
	Crew Julie	Simulator Operator	Checklist
	Operator	Simulator	ASA-20 Tape
	TACCO	Enlisted Instructor	Checklist
	Nav	Enlisted Instructor	Checklist
	Jezebel	Simulator	Log/Graphic Presentation
	PPC	DCC	Checklist
3, 4, and 5	Active Buoy		
	Crew Jezebel	Simulator Operator	Checklist
	Operator	Simulator	Log/Graphic Presentation
	Julie		
	Operator	Simulator	ASA-20 Tape
	TACCO	Enlisted Instructor	Checklist
	Nav	Enlisted Instructor	Checklist
	PPC	DCC	Checklist
3, and 5	MAD		
	Crew MAD	Simulator Operator	Checklist
	Operator	Simulator	RO-32 Tape
	TACCO	Enlisted Instructor	Checklist
	Nav	Enlisted Instructor	Checklist
	PPC	DCC	Checklist

DCC CHECKLIST

Date: ______________________ Class: ______________________

Crew: ______________________ WST No.: ______________________

Name: ____

( ) Check appropriate mission parameters initiated

- ( ) Target Nos. 1, 2, and 3 as appropriate
- ( ) Primary target heading
- ( ) Primary target speed
- ( ) Surface/subsurface status of primary target
- ( ) ASW aircraft located
- ( ) Sound characteristics set
- ( ) Winds Set
- ( ) Associated sea state set.

( ) Mission time-hack taken among data collection team

Remarks: ____

Date: ________________ Crew: ________________ WST: ________________

EVENT: ASW Mission to include Nav Stab, Search, Localization, and Attack.

MEASURING EQUIPMENT: Patrol Pilot Commander (PPC) Bearing Distance Heading Indicator (BDHI).

DCC ACTION: Record time and BDHI indicators at "Mark on Top," Mark at Buoy drop, and Weapons Store drop as follows:

(1) During Nav Stab, record time and BDHI indicator readings at each "Mark on Top."

(2) During Search (LOFAR, Radar, ECM), record time and BDHI indicator readings when CODAR, Julie, or Active Buoy marker buoy is dropped.

(3) During CODAR Localization, record time and BDHI indicator readings when Julie or Active Buoy marker buoy is dropped.

(4) During Julie, Active Buoy or MAD Pattern, record time and BDHI indicator readings when weapons store is dropped.

Event and Type					BDHI		
Nav Stab	Search	Localization	Attack	Time	A/C Ground Trk	Tgt Trk	Counter

Event and Type				BDHI			
Nav Stab	Search	Localization	Attack	Time	A/C Ground Trk	Tgt Trk	Counter

SIMULATOR OPERATOR INSTRUCTIONS

You are asked to complete the attached checklist, or portions thereof, during each Weapons System Trainer (WST) session.

The checklist contains four pages. Each page representing one, or more, phases of the WST Mission. You are asked to complete page 1 at the beginning of each session. You are asked to complete pages 2, 3, and 4, as applicable. At the top of those pages are noted the Event, required Simulator Equipment Settings, and your Data Collection Procedures. The remainder of each page is to be used for data recording.

Please review the entire checklist and indicate questions you may have concerning it.

SIMULATOR OPERATOR CHECKLIST

Date: ______________________ Class: ______________________

Crew: ______________________ WST No.: ______________________

Name: ______________________ ProblemStart Time: ________

Problem Difficulty Level

(1) Primary Target No. 1: Course __________ Speed __________

Target No. 2: Course __________ Speed __________

Target No. 3: Course __________ Speed __________

(2) Winds: Direction ______________________ Speed __________

Other Sea State Info: ______________________

____

(3) Sound Characteristics: ______________________

____

____

____

(4) Median Range of the Day: ______________________

Date: ______________ Crew: ______________ WST: ______________

EVENT: Nav Stab

MEASURING EQUIPMENT: Graphic Presentation Bearing/Distance Indicator

OPERATOR ACTION: Select Aircraft/Marker Buoy readouts on Graphic Presentation indicator. Record Mark on Top Number, Time, and Bearing/Distance reading at each "Mark," in the spaces provided.

If you are directed to initiate any changes in target parameters, i.e., speed, heading, or surface/subsurface status, please record the time and nature of change(s).

Parameter Changes	Mark on Top Number	Problem Time	Bearing	Distance

Date: _______________ Crew: _______________ WST: _______________

EVENT: LOFAR/RDR/ECM/CODAR

MEASURING EQUIPMENT: Graphic Presentation Bearing/Distance Indicator.

OPERATOR ACTION: Select Aircraft/Target readouts on Graphic Presentation Indicator. Record Bearing, distance, and time on drop of marker "checker buoy" at CODAR, Julie, or Active Buoy pattern.

Parameter Changes	CODAR	Julie	Active Buoy	Problem Time	Bearing	Distance

Date: _______________ Crew: _______________ WST: _______________

EVENT: Julie/Active Buoy/MAD

MEASURING EQUIPMENT: Graphic Presentation Bearing/Distance indicator.

OPERATOR ACTION: Select Aircraft/Target readouts on Graphic Presentation Indicator. Record time, and bearing/distance at time of weapons store drop.

Parameter Changes	Weapon Drop			Problem Time	Bearing	Distance
	Julie	Active Buoy	MAD			

INSTRUCTOR CHECKLIST

Date: ____________________ Class: ____________________

Crew: ____________________ WST No.: ____________________

Name: ____

Instructions

You are asked to complete the attached checklist or portions thereof, during each Weapons System Trainer (WST) session.

The checklist contains three pages. Page 1 requests data concerning the date, training crew, WST number, and yourself. This information should be completed prior to the start of each session. You are asked to complete pages 2 and 3, as applicable. At the top of each page are noted the Event, Simulator Equipment involved, and Data Collecting Procedures. The remainder of the page is to be used for data recording.

Please review the entire checklist and indicate questions you may have concerning it.

Date: ______________ Crew: ______________ WST: ______________

EVENT: Nav Stab

MEASURING EQUIPMENT: Navigator's 1D-995 wind face and tactical coordinator's bearing/distance heading indicator BDHI.

INSTRUCTOR ACTION:

(1) Record 1D-995 wind face setting (AM/LN2C mode), as inserted by Navigator after initial airmass computation to include time of setting and parameters. If, and when the Navigator changes wind face settings (AM/LN2C mode), record the time, and parameters of each change.

(2) Record initial Tactical Coordinator BDHI setting (ASA-16 mode), to include time and parameters. Record, as they occur, changes in BDHI settings (ASA-16 mode) to include time and new parameters.

Problem Time	Wind Face		BDHI		
	Direction	Speed	Ground Track	A/C to Marker	Counter

Date: ______________ Crew: ______________ WST: ______________

EVENT: Search/CODAR/Julie/Active Buoy/MAD

MEASURING EQUIPMENT: Tactical Coordinator's Bearing/Distance Heading Indicator (BDHI).

INSTRUCTION ACTION: Check above event in Programmer, Problem time, and BDHI indicators (ASA-16 mode), inserted by Tactical Coordinator as a fly to target, for the purpose of dropping a marker buoy or a weapons store. Record time and BDHI parameters that are changed by the Tactical Coordinator between initial insert and buoy/weapons store drop.

Event (✓)							BDHI		
LOFAR	RDR	ECM	CODAR	Active Buoy	MAD	Problem Time	Ground Track	A/C to Target	Counter

APPENDIX C

DATA COLLECTION FORMS FOR STUDY NO. 2

Date: ________ TACCO Instructor: ________

WST/ASW No.: ________ Crew: ________

Experimenter's Log

Simulator/Aircraft initial conditions

(1) Aircraft

position ________
altitude ________
course ________
speed ________

(2) Submarine

position ________
course ________
speed ________
start depths ________
MDR DEEP ________
MDR SNORKLE ________

(3) Navy Surface Vessel

position ________
course ________
speed ________
MDR ________

(4) Merchant Ship

position ________
course ________
speed ________
MDR ________

(5) WIND ________

(6) DATUM ________

____

PILOT/TACCO/NAVIGATOR—SIMULATOR/AIRCRAFT PERFORMANCE

Mission Task	Correct Procedure YES	Correct Procedure NO	Record Time	Accuracy	Remarks
I. <u>NAV STAB NAVIGATOR SYSTEMS CHECK</u>					
<u>DOPPLER</u>					
1. First MOT/Compute Drift Rate					
2. LOG Drift Rate				Yds/min	
<u>WIND FACE</u>					
1. Switch to Air Mass Computer					
2. Enter best wind					
3. First MOT/Computer Correction Vector					
4. Change wind face				Yds/min	
<u>TACCO</u>					
<u>Drift Comp</u>					
1. Turn drift computer ON					
2. MOT/zero timer					
3. 2 NM selected ASA-16					
4. GPI correct					
5. Depress Green light					
<u>PILOT</u>					
1. OTPI Procedures					
2. ICS Procedures					
3. MOTS				Yds/min	

PILOT/TACCO/NAVIGATOR — SIMULATOR/AIRCRAFT PERFORMANCE

Mission Task	Correct Procedure		Record Time	Accuracy	Remarks
	YES	NO			
II. SEARCH PHASE					
1. TACCO Asks Nav for range and bearing to datum as per WST Standards Sheet					
2. NAVIGATOR Plots and passes datum to TACCO					
3. TACCO Selects datum on BDHI					
4. TACCO GTP-4 20 NM scale and inserts datum target center on local control box					
5. After dropping search pattern MOT STAB Store					
6. Buoys repositioned correctly					
7. Wind face correction					
8. CLF				NM	
9. HLF				NM	
10. DROP CHECKER Buoy					
a. Strength 1, 2, or 3 reported					
11. TARGET CENTER 4 to 1 scale selected GTP-4					
12. TACCO GIVE PILOT Radials/Radius for CODAR Plant/DIFAR Buoy Positions					

PILOT/TACCO/NAVIGATOR — SIMULATOR/AIRCRAFT PERFORMANCE

Mission Task	Correct Procedure		Record Time	Accuracy	Remarks
III. LOCALIZATION	YES	NO			
1. CODAR/DIFAR Fix Developed				Course Speed	
2. TACCO turns on Drift Comp on Plant CHARLIE/DIFAR STAB Buoy when Dropped					
3. TACCO Target Position Info OCT/PP to Pilot GTP-4					
4. Target Center GTP-4 4 to 1					
5. Run into DATUM					
6. 1 to 1 NM scale Target Center GTP-4					
7. Drift Comp Procedures					
8. TACCO Positions Markers on Ambiguous Fixes and OCT/PP Inserts Given to Pilot					
9. Time to Solve Ambiguity					
	Reasonable			Excessive	
10. Transition Tactic					
11. Transition Procedure Inserted New Datum to Pilot on GTP-4 TGT/GTR					

PILOT/TACCO/NAVIGATOR — SIMULATOR/AIRCRAFT PERFORMANCE

Mission Task	Correct Procedure		Record Time	Accuracy	Remarks
	YES	NO		(Check one)	
12. Pilot Ability to Lay Pattern				EX GOOD FAIR POOR	
13. TACCO Utilization of Active SONO to Solve Ambiguity				EX GOOD FAIR POOR	
14. Ambiguity Solved to Providing Pilot OCT/PP Inserts of TGT Position			Elapsed Time		
15. Attack Criteria Announced					
16. Attack					

JULIE ECM INSTRUCTORS
PERFORMANCE CHECKLIST

DATE ____________ CREW ____________

OPERATOR ____________ INSTRUCTOR ____________

	Correct Procedure		
1. ASA-20 OPERATIONS	YES	NO	
a. Pen Setting			
b. SUS/Active Data Recognized			No. possible times ___ No. times ___
c. Echoes Recognized and Accurately Measured ±200 yds			No. possible times ___ No. times ___ Distance off ______
d. Echo Ranges Promptly Reported with Doppler if Active Buoy			No. possible times ___ No. times ___
e. Proper employment of AOB Switch and A/B Hold to Indicate Correct Ranges and Correct Channelization of Receivers			
f. Aural characteristics evaluated and reported			Total possible ___ Total reported ___
g. Bottoms recognized			Total possible ___ Total recognized ___
h. Apparent Water Depth Reported Prior to 5th Charge			
i. Call Ranges Reported on First Change Monitored on a Sonobuoy Pair			

JU. ECM INSTRUCTORS
PERFORMANCE CHECKLIST

DATE ____________ CREW ____________

OPERATOR ____________ INSTRUCTOR ____________

	Correct Procedure			
	YES	NO	No. Analyzed	Total Possible
2. ECM Interpretation				
a. All Intercepted Signals Within Search Band Recognized and Reported				
b. Interrupted Signals of Interest Completely Analyzed				
(1) Frequency/Band				
(2) PRF				
(3) PW				
(4) SCAN (type/period)				
(5) Direction				
(6) Evaluation				
(7) Bearing Accuracy				

JULIE ECM AURAL INTERPRETATION

	CORRECT	INCORRECT
a. Classification		
BR		
TR		
Diesel		
Biologics		
No Contact		
Other		
b. RPM ± 10%		
c. Estimate of Source Strength		
d. Interpretation Promptly Reported to TACCO		

JULIE ECM AURAL INTERPRETATION

	CORRECT	INCORRECT
a. Classification		
BR		
TR		
Diesel		
Biologics		
No Contact		
Other		
b. RPM ± 10%		
c. Estimate of Source Strength		
d. Interpretation Promptly Reported to TACCO		

JULIE ECM RECORDS

DATE ____________ CREW ____________

OPERATOR ____________ INSTRUCTOR ____________

	Total No. Correct Entries	Total Possible Points
1. <u>ASA-20 RECORDS</u>		
a. ASA-20 annotated in accord with NATOPS		
b. Magnetic tape annotated in accord with NATOPS		
c. ASA-20 tape annotated with buoy channels monitored		
d. Julie tape annotated with charge numbers or time of charge every 3 minutes when monitoring active buoys		
e. DETS (pulses) echoes, bottoms marked		
f. Ranges logged		
g. Magnetic tape recording of sonobuoy audio and tactical ICS channels ranges, doppler, and time		

JULIE ECM RECORDS

DATE ____________ CREW ____________

OPERATOR ____________ INSTRUCTOR ____________

	Total No. Correct Entries	Total Possible Points
1. ASA-20 RECORDS		
a. ASA-20 annotated in accord with NATOPS		
b. Magnetic tape annotated in accord with NATOPS		
c. ASA-20 tape annotated with buoy channels monitored		
d. Julie tape annotated with charge numbers or time of charge every 3 minutes when monitoring active buoys		
e. DETS (pulses) echoes, bottoms marked		
f. Ranges logged		
g. Magnetic tape recording of sonobuoy audio and tactical ICS channels ranges, doppler, and time		

JULIE ECM RECORDS

DATE ______________________ CREW ______________________

OPERATOR ______________________ INSTRUCTOR ______________________

	Total No. Correct Entries	Total Possible Points
1. ASA-20 RECORDS		
a. ASA-20 annotated in accord with NATOPS		
b. Magnetic tape annotated in accord with NATOPS		
c. ASA-20 tape annotated with buoy channels monitored		
d. Julie tape annotated with charge numbers or time of charge every 3 minutes when monitoring active buoys		
e. DETS (pulses) echoes, bottoms marked		
f. Ranges logged		
g. Magnetic tape recording of sonobuoy audio and tactical ICS channels ranges, doppler, and time		

JULIE ECM RECORDS

DATE ______________ CREW ______________

OPERATOR ______________ INSTRUCTOR ______________

	Total No. Correct Entries	Total Possible Points
2. ECM RECORDS		
a. Magnetic tape annotated in accord with NATOPS		
b. Heading information complete		
1. On NAVCM/ECM search log		
2. On NAVCM/ECM Intercept log		
c. Search log complete		
d. Photographs of intercepts annotated		
e. Intercept log complete		
1. Signal analysis (Column 28-60)		
2. Fixing information including time, bearing, aircraft position		
3. Signal pulse slope		
f. Photograph of intercept		
g. Magnetic tape of intercept of interest with RENT Report preceded and followed by reference tone and time		

CREW ______________________ DATE ______________

OPERATOR ______________________

JEZEBEL RECORDS

a. Heading information on each log

1. Total possible entries _____

2. Total entries completed _____

b. GRAM annotated in accordance with NATOPS

1. Total possible GRAM annotations _____

2. Total annotations accomplished _____

c. Time marks on GRAM with corresponding log entries for LOFAR and CODAR

1. Total entries possible _____

2. Number entries missed _____

d. Relator frequency and related bearing logged

1. Total entries possible _____

2. Total entries missed _____

e. Log accuracy and completeness

1. Buoys monitored, total entries possible _____, No. missed _____

2. Start and stop, total entries possible _____, No. missed _____

3. CODAR plant designation bearing, total entries possible _____, No. missed _____

4. Gained-lost contact, total entries possible _____, No. missed _____

f. Magnetic tape annotated in accord with NATOPS

1. Number of annotations required _____

2. Number of annotations completed _____

JEZEBEL INSTRUCTORS
PERFORMANCE CHECKLIST

DATE ____________ CREW ____________

OPERATOR ____________ INSTRUCTOR ____________

	Correct Procedure YES	NO	Remarks
1. Search			
a. Artifact checks			
b. Recognition of LOFAR contacts			b1. Indicate number of recognized contacts _____, No. possible _____
c. Correct fundamental frequencies ±0.25			
d. Correct evaluation of signature sources including mode of operation			b2. Indicate number of contacts correctly classified _____
e. Predominant harmonics in order of predominance			
f. Signature start and stop time noted			f1. Indicate total number of starts, _____ total number of stops, and total number of starts noted _____, total number of stops noted _____
g. Central characteristics of signature evaluated and reported			g1. Indicate number of times not reported _____
2. Localization			
a. Sync/cal immediately prior to coder			
b. Bearing lines accurately read and reported ±3 degrees			b1. Number of times not accurately reported _____, total possible _____
c. Bearing lines characteristics and changes noted and reported			c1. Number of times not noted and reported _____, total possible _____
d. Utilization of available CODAR bands/frequencies			
e. Utilization of relator when multiple bearing lines are present			
f. LOFAR fixing (LOFIX) opportunities recognized			f1. Total possible _____, total recognized _____
g. LOFIX evaluations performed correctly and accurately			

RADAR - MAD
INSTRUCTORS PERFORMANCE CHECKLIST

DATE ______ CREW ______

OPERATOR ______

INSTRUCTOR ______

	Correct Procedure YES	Correct Procedure NO	
1. Radar Interpretation			
a. Adherence to brief EMCOM procedures			
b. Timeliness and thoroughness of reporting contacts			
2. MAD Interpretation			
a. MAD oriented in operating area and reoriented as necessary			
b. MAD operated at most sensitive setting practicable			
c. Timely recognition and reporting of valid contacts			Total number of contacts ______, total number reported ______
d. Spurious signals recognized			Number of inaccurate annotations ______

RADAR/MAD - RECORDS

DATE ____________ CREW ____________________

OPERATOR ______________________ INSTRUCTOR _________________

1. Radar Records

a. Heading information

(1) Total possible entries _____ (2) Total number of entries _____

b. Time and event columns

(1) Total possible entries _____ (2) Total number of entries _____

c. Contact position or bearing and range logged for the following events: SNK, RE, GN, CL

(1) Total possible entries _____ (2) Total number of entries _____

d. Events GN or RG evaluated

(1) Total possible entries _____ (2) Total number of entries _____

e. Events GN or RG contact numbers assigned

(1) Total possible entries _____ (2) Total number of entries _____

f. Reference point for all position entries recorded if other than aircraft

(1) Total possible entries _____ (2) Total number of entries _____

g. Actual coverage, if less than 360 degrees, contained in remarks and maximum range of surface contact at altitude

(1) Total possible entries _____ (2) Total number of entries _____

(3) Accuracy _____

MAD RECORDS

	No. of Possible Annotations	No. of Actual Annotations
1. Mad tape annotated in accord with NATOPS		
2. Mad tape annotated with operating information.		
a. Preflight		
b. Orientation		
c. HATS		
d. Spurious signals		
e. Time tape drive ON/OFF		
f. Comex and Finex times		

APPENDIX D

TRAINING DEVICE EVALUATION QUESTIONNAIRE

P3B TRAINER EFFECTIVENESS EVALUATION

POSITION UNDER EVALUATION: ______ Pilot/Copilot

______ TACCO

______ Navigator

______ Radar/MAD Operator

______ Julie/ECM Operator

______ Jezebel Operator

As part of the evaluation of training device effectiveness being conducted for the U. S. Navy we would like you to answer the following questions as completely and honestly as you can. <u>This is not a test</u> - there are no right or wrong answers. Rather what we are after is your carefully considered responses based on your own experience and competence.

When answering these questions, please consider <u>only</u> the position checked above or the <u>entire</u> team. Please be as detailed in your responses as you can.

P3B TRAINER EVALUATION QUESTIONNAIRE *

1. Overall, how effective would you say the training device is as a trainer for this position?

Low Effectiveness — High Effectiveness

2. How effective are the problems and problem characteristics in providing training for this position?

Low Effectiveness — High Effectiveness

Would you change the problems or the problem characteristics in any way for training purposes? If so, what changes would you make?

3. How effective do you think the trainer is compared to an equivalent amount of inflight training?

Low Effectiveness — High Effectiveness

Are there any aspects of the operational ASW mission (e.g., coordination, target information, etc.) for which the trainer provides better training than the inflight training missions do? If so, please discuss them.

Are there any aspects of the operational ASW mission for which the inflight training missions provide better training than the trainer does? If so, please discuss them.

4. How realistic are the displays of sensor data and/or other information at this position in the trainer?

Low Realism ——————————————— High Realism

What improvements would you suggest where?

5. For a number of reasons (e.g., poor or failed equipments, type of target utilized, level of performance in the other positions) both the WST and ASW training sessions can be considered to be simulations of the "real" operational mission. In question 5a we would like you to evaluate the realism of both training environments, while in question 5b we would like you to evaluate the effectiveness of both training environments for different stages or types of training.

5a. How realistic are the feedbacks provided by each of the training environments (trainer vs. inflight aircraft) in response to the student's performance inputs during the problem?

TRAINER:		AIRCRAFT:	
Low Realism	High Realism	Low Realism	High Realism

5b. How effective is each of the training environments for each of four types of training: (1) Demonstration and initial practice, (2) Develop ment of proficiency, (3) Refinement of technique once proficiency has been acquired, and (4) Development and practice of new tactics. (If you feel the answer to this question depends on whether one considers just the position you are evaluating or whether one considers, instead, the performance of the entire team as a coordinated unit, then please evaluate both. Use an "x" for the position under consideration and an "o" for the team as a whole.)

	TRAINER		AIRCRAFT	
DEMO & PRACT				
DEV OF PROF				
TECHNIQUE				
NEW TACTICS				
	Low Effective-ness	High Effective-ness	Low Effective-ness	High Effective-ness

6. Please compare and rate the realism of the trainer to the inflight situation for the following eight items. (Notes: (1) If the use of a sub vs. a surface vessel makes a difference, then use an "x" for the comparison of the trainer to a flight using a sub and an "o" for a surface vessel flight. (2) If an item is not applicable to the position you are evaluating, please mark it NA and proceed to the next item.)

TARGET INFORMATION RECEIVED

Low Realism High Realism

BUOY INFORMATION RECEIVED

Low Realism High Realism

MATCH OF THE ELECTRONIC TO THE REAL WORLD

Low Realism High Realism

TACCO/SENSOR OPERATOR INTERACTION

Low Realism High Realism

TACCO/PILOT INTERACTION TO CONTROL GUIDANCE

Low Realism High Realism

TACCO/NAVIGATOR ESTIMATION OF COURSE

Low Realism High Realism

TACCO/NAVIGATOR ESTIMATION OF SPEED

Low Realism High Realism

TACCO/NAVIGATOR ESTIMATION OF POSITION RELATIVE TO BUOYS

Low Realism High Realism

7. Please compare and rate the <u>effectiveness</u> of the trainer for instruction of a student in the following (if an item is not pertinent to the position you are evaluating, please mark it NA and proceed):

KNOBOLOGY

Low Effectiveness — High Effectiveness

PROCEDURAL USE OF EQUIPMENT

Low Effectiveness — High Effectiveness

INTERPRETATION OF SENSOR DATA

Low Effectiveness — High Effectiveness

UTILIZATION OF SENSOR INFORMATION

Low Effectiveness — High Effectiveness

METHODOLOGY AND TECHNIQUE DEVELOPMENT (e.g., calculations, timing, identification and selection of alternatives)

Low Effectiveness — High Effectiveness

TACTICS

Low Effectiveness — High Effectiveness

TEAM COORDINATION

Low Effectiveness — High Effectiveness

8. In terms of working with the trainee during a training session which aspects of the trainer's design do you feel aid or hinder your efforts as an instructor?

9. Are there any modifications or improvements you would suggest that would allow better or more efficient evaluation of student performance at this station (i.e., either in the form of recording devices, better or more slave equipment, etc.)?

10. What changes in the design or operation of the device do you think should be made in order to enhance the training at this position?

Are there any changes in maintenance you would suggest?

11. Would you change the amount of training time presently spent in the trainer or in the aircraft, or would you suggest any different utilization of the two training environments (e.g., scheduling)? If so, please discuss the changes you would make and explain the expected advantages.

12. What characteristics of the training device, or utilization thereof, would you say contribute to its effectiveness or ineffectiveness for training purposes (but have not been discussed above)?

Effective Characteristics	Ineffective Characteristics

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1 ORIGINATING ACTIVITY (Corporate author)
Bunker Ramo Corporation, Electronic Systems Division, 31717 LaTienda Drive, Westlake Village, California 91306

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3 REPORT TITLE
TRAINING EFFECTIVENESS EVALUATION OF NAVAL TRAINING DEVICES: AN EVALUATION OF THE 2F69B ASW WEAPON SYSTEM TRAINER

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Final Technical Report

5 AUTHOR(S) (First name, middle initial, last name)
James E. Robins; Dorothy L. Finley; Thomas G. Ryan

6. REPORT DATE	7a. TOTAL NO OF PAGES	7b. NO OF REFS
December 1972	124	0

8a. CONTRACT OR GRANT NO
N61339-69-C-0258

b. PROJECT NO
8264-2

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
K0042-2U44

9b OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
NAVTRAEQUIPCEN 70-C-0258-2

10 DISTRIBUTION STATEMENT
Distribution limited to U. S. Gov't. agencies only; covers the test and evaluation of commercial products or military hardware, Dec 1972. Other requests for this document must be referred to Commanding Officer, Naval Training Equipment Center (N-423), Orlando, Florida.

11 SUPPLEMENTARY NOTES

12 SPONSORING MILITARY ACTIVITY
Naval Training Equipment Center
Orlando, Florida

13 ABSTRACT

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DD FORM 1 NOV 65 1473

Unclassified
Security Classification

Unclassified

Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Training Effectiveness ASW Tactics Training 2F69B Weapon System Trainer Airborne Environments						

Unclassified

Security Classification

Naval Training Equipment Center, Orlando, Fla.

TR NAVTRAEQUIPCEN 70-C-0258-2 UNCLASSIFIED
AD__________

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ASW Tactics training
2F69B Weapon System Trainer
Airborne environments

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N61339-70-C-0258
NAVTRAEQUIPCEN
Task No. 8264-2

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TR NAVTRAEQUIPCEN 70-C-0258-2 UNCLASSIFIED
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